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ILLUSTRATIONS OF FUNGI—XI

WILLIAM A. MURRILL

All of the illustrations here shown, except one, were made from plants collected in Bronx Park and the vicinity. Very few of these plants are known to be of economic importance; one or two species are generally classed with the poisonous fungi.

Suillellus luridus (Schaeff.) Murrill

LURID BOLETUS

PLATE 68. FIGURE 1. × 1

Pileus convex, gregarious or subcespitose, 5–12 cm. broad; surface dry, smooth, glabrous or minutely tomentose, sometimes clothed with rather conspicuous appressed, felted fibers, occasionally rimose-areolate, brown with shades of red or yellow, often bright brownish-red, becoming paler with age; margin thick, obtuse, entire, sometimes slightly differing in color; context firm, whitish to flavous, quickly changing to blue when wounded, sometimes unchanging in older plants, considered somewhat poisonous; tubes nearly free, rarely adnate, plane or slightly convex in mass, yellow within, changing to dark greenish-blue when wounded, mouths small, circular, cinnabar-red, becoming brownish-orange, darker with age; spores oblong-ellipsoid, smooth, olivaceous when fresh, 11–16 × 4–6 μ; stipe subequal, 5–10 cm. long, 1–2 cm. thick, usually furfuraceous or punctate, at times nearly glabrous, rarely reticulate at the apex or on the upper half, red or reddish-brown below, yellow or orange above, the dots rosy or dark-red, solid, yellow within, varied with red or purple.

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This is one of the most variable species in the family of fleshy, terrestrial, tube-bearing fungi, but the small genus to which it belongs is readily recognized by its red or reddish tube-mouths, and all of its species should be avoided by mushroom eaters until their properties are better known. This particular species is said to contain a small amount of deadly poison, although it is often eaten. When cut, the entire cut surface of the cap, tubes, and stem changes at once to blue. It occurs often in abundance throughout temperate North America and Europe on clay banks or roadsides in open deciduous woods.

Naucoria subvelosa sp. nov.

SLIGHTLY-VEILED NAUCORIA

PLATE 68. FIGURE 2. × 1

Pileus hemispheric and gibbous to nearly plane, usually slightly umbilicate or depressed, gregarious, 1.5–2.5 cm. broad; surface viscid when wet becoming dry and polished, slightly fibrillose-scaly, especially at the center, the scales and fibrils being thin, reddish-brown, and somewhat imbricate; margin entire or undulate, inflexed when young; context mild to the taste, without odor; lamellae strictly adnate, heterophyllous, arcuate or plane to slightly ventricose, rather close, of medium width, dull isabelline-umbrinous to dirty-brownish with a ferruginous tint; spores ellipsoid, smooth, ochraceous-melleous under the microscope, 8–9 × 5 μ; stipe subequal, citrinous at the apex, isabelline below, subglabrous, bearing the remains of a slight, fibrillose, fugacious veil, cartilaginous to subfleshy, stuffed, averaging 3 cm. long and 2 mm. thick.

Type collected on a wet bank in woods in the Bronx, June 18, 1911, by W. A. Murrill.

Collybidium dryophilum (Bull.) Murrill

OAK-LOVING COLLYBIDIUM

PLATE 68. FIGURE 3. × 1

Pileus thin, convex, umbonate, becoming expanded and plane to depressed with upturned edges, solitary, 3–4 cm. broad; surface glabrous, but with fine radiating lines like appressed hairs, dry, uniformly light-brown; context mild to the taste, without

characteristic odor; lamellae adnexed, white, close, narrow, inserted, ventricose; spores ellipsoid, smooth, hyaline, 8–9 × 3.5–4 μ; stipe hollow, cartilaginous, milk-white at the apex, polished and slightly colored below, 3 cm. long, 2.5 mm. broad.

Collected by Mr. E. C. Volkert, July 31, 1911, on buried decayed sticks, acorns, and grass roots under an oak tree on a lawn in Bronxwood Park, New York City. This form is quite different in appearance from that found so commonly in our woodlands, but agrees well with plants collected in Kew Gardens, England, and elsewhere in Europe in open places. The species is edible, abundant, very variable, and very widely distributed.

Mycena praedecurrens sp. nov.

DECURRENT-GILLED MYCENA

PLATE 68. FIGURE 4. × 1

Pileus conic to subturbinate when young, then umbonate, and at length nearly plane, densely gregarious to subcespitose, reaching 1.5 cm. broad and nearly 1 cm. high; surface glabrous, very slightly viscid when wet, avellaneous, with darker avellaneous umbo; margin straight, appressed, usually striate, often yellowish-white; lamellae long-decurrent, distant, nearly plane, inserted, entire, white with an ashy tint, acute at each end; spores ovoid, smooth, hyaline, 5 × 3–3.5 μ; stipe enlarged at the apex, subglabrous, gelatinous-white, avellaneous at the base, slightly viscid when wet, stuffed, about 4 cm. long and 2 mm. thick.

The type specimens here figured were collected by W. A. Murrill in the Bronx, June 18, 1911, on a mossy bank filled with slender roots, in low deciduous woods. On account of its long-decurrent gills, one might assign it at first sight to *Omphalia,* of the type of *Omphalia Austinii* Peck, but it is not umbilicate. Its nearest relative is probably *Mycena vulgaris.*

Flammula carbonaria (Fries) Quél

CHARCOAL-LOVING FLAMMULA

PLATE 68. FIGURE 5. × 1

Pileus convex to subplane, gregarious to subcespitose, 2–4 cm. broad; surface viscid, smooth, glabrous, testaceous-isabelline, or varying from lighter yellow to orange or testaceous; margin

inflexed when young, with a slight, stramineous, filamentous, evanescent veil; context thin, white or stramineous, taste sweetish, odor pleasant; lamellae squarely adnate or with a short decurrent tooth, plane or arcuate, broad, crowded, inserted, pale-yellow to fulvous; spores ellipsoid, smooth, fulvous in mass, 7×3–$4\,\mu$; stipe equal or slightly enlarged above, hollow or stuffed, white or cremeous, adorned below with reddish-brown fibrils, glabrous or granulose at the apex, 5×0.2–0.4 cm.

This species is very common during summer and fall about burned stumps in the vicinity of New York City. It is sometimes clustered but more often gregarious, and the shining yellowish-brown caps are quite conspicuous. Fries first described the plant in Sweden, and it is known throughout Europe and in the greater part of the United States.

Russula stricta sp. nov.

STRICT RUSSULA

PLATE 68. FIGURE 6. × 1

Pileus firm, convex to expanded, becoming depressed at the center, gregarious, 5 cm. or more broad; surface dry or slightly moist, glabrous, smooth, isabelline with testaceous and ochraceous hues, the cuticle partly separable; context thin, white, firm, taste perfectly mild, odor pleasant; lamellae adnate, a few of them forked, pale-cream, close, rather narrow; spores subglobose, densely and roughly echinulate, hyaline, 6–8 μ long; stipe fleshy, subequal, smooth, glabrous, pallid, milk-white, polished, 5 cm. long, 10–15 mm. thick.

The type of this species was collected by W. A. Murrill, June 14, 1911, in thin oak woods on the eastern border of the New York Botanical Garden. Miss Gertrude S. Burlingham has very kindly compared it with known species of the genus.

Marasmius magnisporus sp. nov.

LARGE-SPORED MARASMIUS

PLATE 68. FIGURE 7. × 1

Pileus very thin, tough, convex, at times prominently umbonate, closely gregarious, 1–1.5 cm. broad; surface white to pale-isabelline with a pinkish tint, glabrous, sometimes slightly striate; con-

text mild; lamellae decurrent, broad, distant, strongly interveined, inserted, white, entire; spores large, oblong, smooth, hyaline, 10–12 × 4–6 μ; stipe increasing upward, tough, minutely longitudinally striate, pruinose to glabrous, grayish-avellaneous below, paler above, 1–3 cm. long, 2 mm. thick.

Type collected on a dead deciduous log in the New York Botanical Garden, August 28, 1911, by *W. A. Murrill.* Found commonly on dead wood in moist or shaded situations about New York City during late summer and autumn. Professor Pennington, who assigns it to the same group with *M. Vaillantii* Fries, collected it at Washington, D. C., last August on several occasions and noted considerable variation in it. *Marasmius viticola* Berk. & Curt. is a closely related species occurring in the eastern United States farther south.

Anthurus borealis Burt

NORTHERN ANTHURUS

PLATE 68. FIGURE 8. × 1

Sporophores solitary or clustered, 10–12 cm. high; stipe white, divided above into six, usually, but sometimes five or seven, narrowly lanceolate hollow arms; arms incurved above, with pale flesh-colored backs traversed their entire length by a shallow furrow; cavity of the stipe nearly closed at the base of the arms by a diaphragm through which there is an opening upward into a closed chamber with a dome-shaped wall; gleba supported on the dome and closely embraced by the arms; spores oblong, hyaline, 3–4 × 1.5 μ, borne on cross-septate basidia constricted at the septa.

This interesting and remarkable species was first described as above by Mr. E. A. Burt from New York specimens, and was later collected in Massachusetts, growing in both states in gardens or cultivated fields. It was brought to my attention in May, 1911, by Dr. F. M. Bauer, Superintendent of the Metropolitan Hospital on Blackwell's Island in this city, who found quantities of it in his mushroom beds and supplied me with a number of specimens for colored drawings and photographs.

The odor of the mature sporophore is very vile and penetrating at close range, somewhat resembling that of fresh guano, but it is not pervading like that of *Dictyophora duplicata,* for example, and

also lacks the "faint" quality of most stinkhorns. The slime containing the odor is inside the five rays and oozes through the spaces between them as they spread slightly. The "eggs" are in clusters of three or four or more, and about 3.5–4 cm. in diameter. A section of the "egg" shows the conspicuous pileus enclosed by the thin white inner wall, while the stipe is much compressed, until the elongation begins which pushes the pileus rapidly into the air, the odor at the same time advertising to flies that food is at hand in exchange for the dissemination of spores.

Mycena vexans (Peck) Sacc.

VEXING MYCENA

PLATE 68. FIGURE 9. × 1

Pileus conic to broadly convex, the umbo becoming inconspicuous with age, gregarious, 1–2 cm. in diameter; surface glabrous, not viscid, radiate-striate, uniformly fumose-avellaneous, or with the umbo slightly darker when young, margin thin, straight, concolorous; context sweetish, odor pleasant; lamellae adnate, breaking away from the stipe, broad, distant, slightly ventricose, three times inserted, white with an ashy tint; spores ellipsoid, pointed at one end, smooth, hyaline, 8–9 × 5 μ; stipe long, slender, equal, glabrous, avellaneous, nearly white at the apex, hairy at the base, hollow, cartilaginous, 5–7 cm. long, about 2 mm. thick.

The specimens here figured appeared in abundance among needles and twigs beneath a Norway spruce tree in dense woods in Bronx Park, June 14, 1911. The species was described from the Adirondack Mountains in 1885, but seems to be very little known.

Omphalopsis Campanella (Batsch) Earle

Omphalia Campanella (Batsch) Quél.

BELL-SHAPED OMPHALOPSIS

PLATE 68. FIGURE 10. × 1

Pileus thin, toughish, convex, umbilicate, often irregular, usually densely cespitose, 0.7–2 cm. broad; surface delicately striate, hygrophanous in moist weather, yellowish-ferruginous to dull reddish-yellow; lamellae narrow, decurrent, strongly arcuate, yellow, connected by veins; spores ellipsoid, smooth, hyaline,

6–7 × 3–4 μ; stipe very slender, polished, pale-brown, hollow, erect or ascending, 1–3 cm. long, adorned with brown hairs at the base.

This is one of our prettiest woodland species, found commonly and widely distributed in Europe and North America on dead coniferous wood. Its color is rather sober, but it is conspicuous by reason of its clustered habit and attractive because of its shapely form. It may be found throughout the growing season. The accompanying figure was drawn from specimens collected in late autumn, and fresh sporophores were found in the same spot the following spring at the end of April.

THE LARGE LEAF SPOT OF CHESTNUT AND OAK

ARTHUR H. GRAVES

(WITH PLATE 69, CONTAINING 5 FIGURES)

This disease we have named the "large leaf spot" in contradistinction to the small leaf spot, the latter being common on chestnut leaves, and, as is well known, caused by the fungus, *Septoria ochroleuca* B. & C.

In the summer of 1910, during a survey of the diseases of the forest trees in the Southern Appalachian region, in collaboration with the U. S. Forest Service, the writer found the large leaf spot occurring abundantly on leaves of *Castanea dentata* in Bedford County, Virginia; in Transylvania, Jackson and Macon Counties, North Carolina, and in Rabun County, Georgia. It was found commonly also on leaves of *Quercus rubra* L. in Transylvania County, North Carolina.

A similar disease has been briefly mentioned by Stevens and Hall[1] under the title of Monochetiose, in their recent book on Diseases of Economic Plants. Stating that it is abundant in the forests on chestnut leaves, and causes much loss of vigor to the tree, they refer to *Monochaetia pachyspora* Bubák as the fungous agent. The disease which they mention may be the same as that observed by the writer, and if this is so, it is probably more correct to refer it to *Monochaetia Desmazierii* Sacc. This point, however, will require further investigation.[2] Beyond the brief statement in the above mentioned work, we have been unable to find any other definite reference to such a disease in the literature.

SYMPTOMS

On leaves of the chestnut, the large leaf spot begins to make its appearance (about August 1, in the localities visited) as small,

[1] Stevens, F. L., and Hall, J. G., Diseases of Economic Plants 438. 1910.

[2] No material of this leaf spot described by Stevens and Hall is at present available, but in all probability a new supply will be obtained this summer.

circular spots, from 1–2 cm. in diameter, on apparently healthy leaves. These spots are usually pale, with a darker line around the margin, and vary in different specimens between shades of yellow, gray, or red-brown. As the disease advances, concentric zones are added to the original diseased spot, each succeeding zone of the same nature as the original area, *i. e.*, with a darker margin bordering an interior paler area. Thus, at length, large circular spots are formed, composed of concentric, circular bands. (Pl. 69, fig. 4, and text fig. 1a.), These large spots often

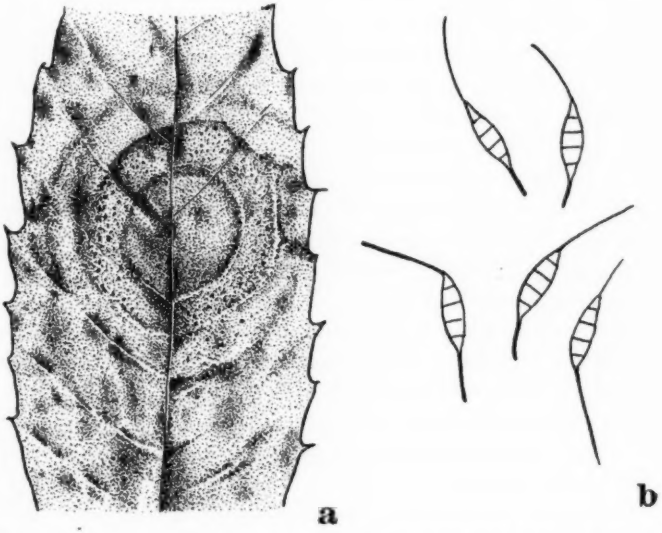

FIG. 1. a. Leaf of *Castanea dentata* showing large leaf spot. × 1. b. Spores of *Monochaetia Desmazierii* Sacc. × 600.

measure 5 or 6 cm. in diameter, stretching across the entire width of the leaf. Several large spots occurring on a single leaf may join each other, and the whole tissue in the distal portion of the leaf may thus be killed. Often, in this way, over half of the leaf may be killed. The zones are generally more clearly delineated on the upper surface of the leaf. The under side of the leaf has a whitish mouldy character on the margin of the diseased area, due to a projecting growth of the mycelium.

The disease as it appears on the leaves of *Quercus rubra* L. exhibits similar symptoms.

THE FUNGUS

The fungus causing this disease belongs to the order Melanconiales of the Fungi Imperfecti. Specimens have been submitted to Professor Farlow, who has pronounced it probably the same as *Monochaetia Desmazierii* Sacc. This fungus was originally described by Desmazières,[3] who found it in France, growing on dry or fading leaves of several species of deciduous oaks, and also on *Quercus Ilex*. It developed not on fallen leaves, but on those which remained on the tree. Desmazières named the new species *Pestalozzia monochaeta,* thus emphasizing the fact that the spores terminated in a single bristle.

Saccardo,[4] in the third volume of his Sylloge Fungorum, published in 1884, includes this and other species of *Pestalozzia* having one bristle under the section *Monochaetia*. In 1903, Allescher[5] in Rabenhorst's Kryptogamen-Flora raised this section to generic rank, thus giving the species in question the name of *Monochaetia monochaeta* (Desm.) Allescher. Such a name, however, was practically contrary to the rules of nomenclature, although, indeed, the spelling of genus and species was not exactly identical. Thus, later, Saccardo[6] in his Sylloge Fungorum evidently recognized the need of a further change, and consequently the name appears in his work at this time as *Monochaetia Desmazierii* Sacc.

According to Saccardo's description of the species, the spores are apparently smaller than ours. Professor Farlow has, however, examined the original material distributed by Desmazières himself, and finds that the spores there were immature. In material distributed later by Desmazières, which is mature, the measurements of the spores correspond to ours. This later material of Desmazières, moreover, corresponds to his own description, and

[3] Desmazières, J. B. H. J., Seizième Notice sur les Plantes cryptogames récemment découvertes en France. Ann. Sci. Nat. III. **10**: 355, 356. 1848.

[4] Saccardo, P. A., Sylloge Fungorum **3**: 797. 1884.

[5] Allescher, Andreas, in Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. ed. 2. **1**[7]: 667. 1903.

[6] Saccardo, P. A., Sylloge Fungorum **18**: 485. 1906.

should be looked upon as the true *Monochaetia Desmazierii*. It is probable that Saccardo's smaller measurements were taken from the first lot of material distributed by Desmazières. Without going into more detail, it is sufficient for our purposes to state that the correct description of the species is given by Voglino.[7]

The spores make their appearance early in the progress of the disease, and are borne in dense clusters, or acervuli, which appear to the naked eye as small black dots on the diseased portions, usually on the upper surface of the leaf. In shape the spores are ellipsoid, and usually divided into five cells, as shown in the accompanying text figure. The three central cells are large and dark colored, while the two end cells are small and transparent. Sometimes only two, instead of three central cells appear. At the base of the spore there is a short stipe, 5–10 μ long. At the tip a long flagellum, or bristle, is borne, which usually describes a curve near its base, and is quite variable in length, 10–25 μ. The average size of the spore, including all of the cells, but omitting the stipe and flagellum, is $20 \times 6\ \mu$.

Successful infection experiments have been carried on with this fungus. Out of a large number of chestnuts sown in the greenhouse early last November, a few germinated in December and later, without waiting over until spring. By the middle of January these furnished fine healthy young trees for inoculation. The leaves were inoculated with the spores in two ways: first, by applying the spores to the surface of the leaf after wetting it with sterilized water, and, second, by wounding the leaves and inserting the spores in the wounded spots. The infections made by the latter method were invariably successful, while the former method did not always cause the disease. On the basis of these results it would appear that wounds from insect bites or mechanical causes may probably furnish in nature the starting point of the disease in many cases, and yet there is no doubt that the fungus can enter the leaf without this assistance. It is probable that the age of the leaf has some relation to infection, and investigations along this line are now being carried on.

[7] Voglino, P., Sul Genere Pestalozzia. Saggio Monografico. Atti della Società Veneto-Trentina di Scienzi Naturali 9^2: 7. 1885.

Cultures of the fungus have been made on various media. For abundant spore production and vigorous mycelial growth Clinton's[8] oat agar gave the best results. Figure 1 shows a plate culture two weeks old, on this medium. The spores here, in the central darker portion, are extremely dense. For comparison, figure 2 shows a culture of the same age, on potato juice agar. Here only a few acervuli, shown by the black dots, appear. In figure 3 some of the spores produced on the oat agar are shown. They are somewhat larger than those occurring in nature, and also considerably distorted. Figure 5 shows a germinating spore.

ECONOMIC IMPORTANCE AND CONTROL OF THE DISEASE

In some cases, individual trees were observed which had suffered a loss of perhaps 40 per cent. of the green assimilating tissue of their leaves as a result of the attacks of this fungus. Usually, however, the damage is much less than this, but always sufficient, it is believed, to cause a considerable diminution in the annual wood increment. Since it appears that this trouble is disseminated over the whole southern Appalachian region, it is one of considerable importance.

As far as the disease occurs in the forest, very little can be done at present to check it. In case of individual trees on private estates or in parks, however, the ordinary methods of spraying will probably prevent its recurrence. The diseased leaves should also be raked up in the fall and burned, as they harbor the fungus spores over winter.

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EXPLANATION OF PLATE LXIX

Fig. 1. Culture of *Monochaetia Desmazierii* in oat agar, two weeks old. × ⅔.

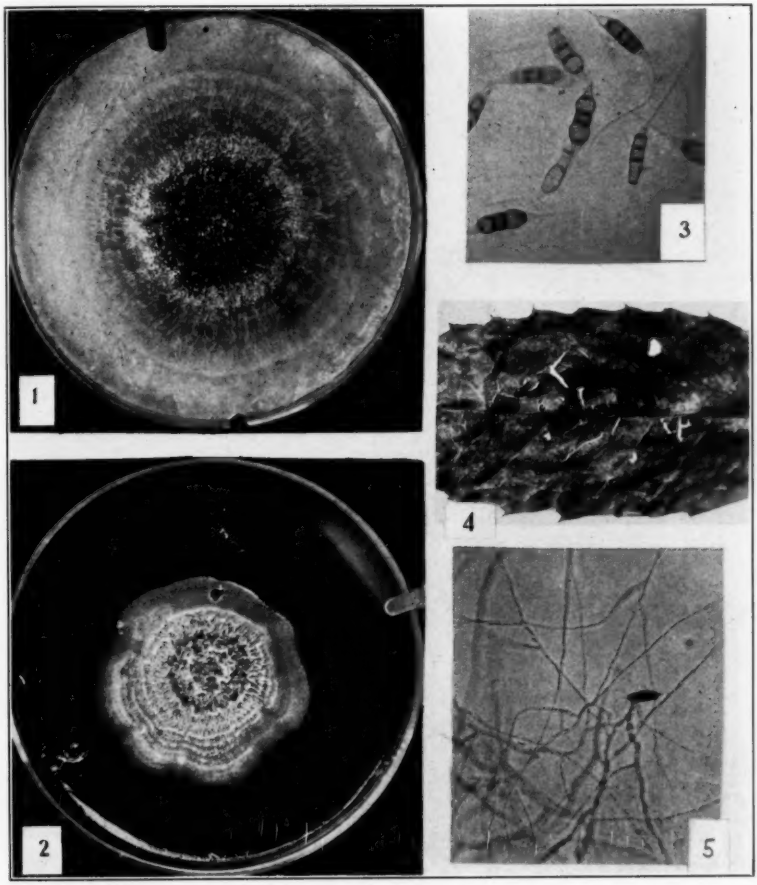
Fig. 2. Culture in potato juice agar, two weeks old. × ⅔.

Fig. 3. Photomicrograph of spores of *Monochaetia Desmazierii* Sacc. from oat agar culture. Spores somewhat abnormal, probably due to influence of culture medium. × 275.

Fig. 4. Photograph of large leaf spot on leaf of chestnut. × ⅔.

Fig. 5. Photomicrograph of germinating spore of *Monochaetia Desmazierii*. × 230.

[8] Clinton, G. P., Rep. Conn. Agr. Exp. Sta. for 1909–10. 760. June, 1911.



MONOCHAETIA DESMAZIERII SACC

CULTURES OF HETEROECIOUS RUSTS

W. P. Fraser

The cultures described in the following pages were undertaken during the spring and early summer of 1911. Special attention was given to the study of the aecia on conifers and their connection with telial forms, but a few cultures of the grass and sedge rusts that field observation suggested were also tried. The success attained was largely due to the excellent opportunity for field observation that the region afforded and the ease with which material could be collected.

The teliosporic material used in the cultures was collected in the districts surrounding the town of Pictou. The greater part was obtained in the spring, but considerable material was collected the previous fall and was left exposed to the weather during the winter in small cheese cloth bags. When the host plants were ready for infection, the leaves or parts of the plants bearing telia were placed in a moist chamber on damp blotting paper and then sprayed with water by means of an atomizer. When it was found by examination that the teliospores had germinated, the germinating teliosporic material was suspended above the host plants so that the basidiospores would fall on the leaves, the whole was then sprayed by an atomizer and covered for from one to several days with a bell jar. This method was satisfactory except that it frequently gave such rich infection that the plants were killed by the abundant pycnia. In all cases the teliospores were found to be germinating before the sowing was made unless stated otherwise in the descriptions. Sometimes it was found that the teliospores did not germinate in the moist chamber for several days; in some cases five to seven days were required for germination, in others a day or less was sufficient. The teliospores of the *Melampsoropsis* rusts, which mature and germinate on the living host plants in the spring, were collected when germinating, or the mature telia were placed immediately after collection in a moist chamber until they germinated freely, which usually took place in about twenty-four hours.

Many of the host plants used in the cultures were obtained in the field and placed in pots in early spring, but some were procured a short time before the experiments were made. Care was taken to select the plants remote from any source of infection and the surrounding plants of the same species from where they were obtained were kept under observation and remained free from infection except in one case which is noted in the description of the experiment. Plants from the same place as those used for the cultures were also kept as checks in every experiment and in no case did infection appear.

The experiments were carried on in a well-lighted laboratory of Pictou Academy, with the exception of one at the end of the season which was performed at the Agricultural College, Truro, N. S.

The writer's thanks are due to Dr. J. C. Arthur for valuable suggestions and assistance, to Professor H. W. Smith, Biologist of the Agricultural College, Truro, for enthusiastic and valuable assistance in field observation in the vicinity of Truro and in the culture carried on at the College, and also to Mr. John Macoun, Naturalist of the Geological Survey of Canada, for determining some of the host plants.

PUCCINIASTRUM PUSTULATUM (Pers.) Dietel

During the summer of 1910 there was a very luxuriant development of this rust on *Epilobium angustifolium* L. in a small area that had been previously swept by fire. The leaves with telia were collected the following spring and gave excellent germination after from four to six days in a moist chamber. A sowing was made on *Abies balsamea* on May 17. Pycnia were noticed on May 24 and aecia on June 1. Another sowing on May 22 gave pycnia on May 29 with aecia on June 4. Infection was very marked in both cultures, practically all the young leaves being infected. Another sowing was made on June 19 with a few pycnia on June 27 and aecia on July 4. By this time the leaves of the host plants were becoming mature and the infection was sparing. A sowing was also tried on *Tsuga canadensis* but without result.

Aeciospores from the culture aecia were sown on *Epilobium*

angustifolium L. on June 14 and the uredinia of *Pucciniastrum pustulatum* were noticed about two weeks later.

In the field where the telia for the culture were collected, a few trees of *Abies balsamea* grew among the rusted *Epilobium*. These were watched for the appearance of pycnia and aecia and the first collection was made on June 19, when the pycnia were well developed but the aecia were not mature. Several collections were made later but the aecia were few considering the abundance of the telia and the fact that all tested in the laboratory gave excellent germination. Probably the scant development was due to the very dry weather that prevailed during May and June until the leaves of the host were too old to be readily infected. In the laboratory tests, at least four days in a moist chamber were necessary for the germination of the teliospores.

European investigators have shown that the aecial stage of this rust is on *Abies pectinata* DC., but as far as the writer is aware these are the first experiments with American material and the first collection of aecia in North America.

CALYPTOSPORA COLUMNARIS (A. & S.) Kuhn

The swollen stems of *Vaccinium pennsylvanicum* Lam. bearing the telial stage of this rust were placed in a moist chamber on May 12 and the teliospores were germinating freely by May 17. A young plant of *Abies balsamea* (L.) Mill. was then infected on the latter date in the usual way. Aecia were first noticed appearing on June 3 and were mature by June 12. There was no trace of pycnia. An attempt was made to infect *Tsuga canadensis* (L.) Carr., but without success.

In the field, aecia began to appear during the last week of June and were abundant on the host in this region (*Abies balsamea*) during the first and second weeks of July.

Arthur (Mycol. **2**: 231. 1910) infected *Abies Fraseri* (Pursh) Poir, using telial material from this region. This is the only previous culture with North American material.

MELAMPSOROPSIS LEDICOLA (Peck) Arthur

Teliosporic material of this rust on *Ledum groenlandicum* Oeder was *sown on Picea canadensis* (Mill.) BSP. on June 5.

Pycnia were evident on June 13 in great abundance and aecia followed in two or three weeks. Two host plants were used and the infection was marked on both. The aecia were without doubt *Peridermium decolorans* Peck. Another sowing on June 17 gave pycnia on June 27 followed by aecia. This confirms the work of last year. (Mycol. **3**: 70. 1911.)

MELAMPSOROPSIS CASSANDRAE (Peck & Clinton) Arthur

Teliosporic material of this rust on *Chamaedaphne calyculata* (L.) Moench was sown on *Picea rubra* (DuRoi) Dietr. on June 16; pycnia were noticed on June 26, and aecia were mature by July 16. Both pycnia and aecia were very abundant. Another sowing on *Picea mariana* (Mill.) BSP. on June 17 gave pycnia which were noticed first on July 3. Aecia followed, but not in abundance, probably owing to the maturity of the leaves. The aecia belonged to *Peridermium consimile* Arthur and Kern. Frequent collections of aecia were made in the field on the *Picea* that grew beside the *Ledum*, which bore germinating telia in the spring. (For previous culture see Mycol. **3**: 68. 1911.)

MELAMPSOROPSIS ABIETINA (A. & S.) Arthur

Teliosporic material on *Ledum groenlandicum* was sown on *Picea rubra* on July 16, with pycnia on June 27 and aecia on July 8, both in great abundance. A sowing was tried on *Picea canadensis* without result, but the leaves were too old for the experiment to have any value as negative evidence. This confirms the work of last year (Mycol. **3**: 69. 1911). The aecia were found to be *Peridermium abietinum*. Several collections were made in the field beside where the telia were germinating on *Ledum* in the spring.

UROMYCES SCIRPI Burr.

Teliosporic material of this rust on *Scirpus campestris* var. *paludosus* (A. Nelson) Fernald (*S. paludosus* A. Nelson) was sown on *Cicuta maculata* L. on June 9. Pycnia appeared on June 16 and aecia followed in a short time, both in abundance. Arthur (*Jour. Myc.* **13**: 199. 1907; **14**: 17. 1908; Mycol. **1**:

237. 1909) has shown by cultures that this rust on *Scirpus fluviatilis* (Torr.) A. Gray has aecia on *Cicuta maculata*.

A species of *Uromyces* on *Scirpus validus* Vahl. was collected near Pictou. The collection differed from typical *Uromyces Scirpi* in having the telia embedded in the tissues and placed immediately beneath the stomata. The teliospores are also short pedicelled and mostly irregular in shape. Dr. Arthur places this collection under *Uromyces Scirpi*. Attempts were made to germinate the teliospores but without success.

UROMYCES PECKIANUS Farl.

Teliosporic material of this rust on *Distichlis spicata* (L.) Greene collected near Pictou was sown on *Atriplex patula* L. on May 16 with pycnia on May 25 and aecia appearing by May 30. Another sowing was made on June 3 with pycnia on June 10 followed by aecia which were mature by June 24. A sowing on *Chenopodium album* L. on June 2 showed pycnia by June 10 followed by abundant aecia which were mature by June 23. These experiments confirm the work of last year (Mycol. 3: 72. 1911).

Two successful sowings were also made on *Salicornia europaea* L., but with such scant infection that little value can be placed on the experiments. It is very probable, however, that the aecia on *Salicornia* belong to this species. The morphology of the aecia support this view.

Attempts were also made to infect *Suedia maritima* (L.) Dumort and *Spergularia canadensis* (Pers.) Don., but without success. It seems probable to the writer, however, that the aecia collected on *Suedia* among the rusted *Distichlis* is connected.

PUCCINIA PERPLEXANS Plow.

Teliosporic material of this rust on *Alopecurus pratensis* L. was collected near Pictou and sowings were made on two plants of *Ranunculus acris* L. June 2. Pycnia were noticed on both June 11 and aecia began to appear June 21. The infection was marked on both plants, the leaves, stem and pedicels being infected.

Aecia developed abundantly in the field on *Ranunculus acris* L.

that grew among the rusted *Alopecurus*. The first collection was on June 28.

The life history of this species has been worked out by Plowright and other European investigators, but this is the first experiment with North American material, so far as the writer is aware.

PUCCINIA ALBIPERIDIA Arth.

A few collections of *Puccinia* on *Carex* were sown successfully on *Ribes* as described below. All are placed under this species for the present, until further study determines their true position.

Puccinia on *Carex intumescens* Rudge was sown on *Ribes prostratum* L'Hér on May 3 with abundant pycnia and aecia on May 12 and May 24 respectively. Another sowing on the same host on May 25 showed pycnia on May 30 followed by aecia in a short time. Two attempts were made to infect young thrifty plants of *Ribes oxyacanthoides* L. but without success. A sowing on *Sambucus racemosa* L. also failed.

Puccinia on *Carex crinita* Lam. was sown on *Ribes oxyacanthoides* L. on May 7 followed by pycnia on May 15 and aecia on the 24th, both in abundance. Another sowing on the same host on June 16 was followed by pycnia on June 21 and aecia on July 2. Infection was very abundant on the young stems and leaves. A sowing on *Ribes prostratum* on May 6 showed pycnia on May 14 and aecia on May 24. Arthur (Jour. Myc. **14**: 13. 1908) sowed teliosporic material from *Carex crinita* successfully on *Ribes Cynosbati* L.

Puccinia on *Carex debilis* var. *Rudgei* (*Carex tenuis* Rudge) was sown on *Ribes prostratum* on May 21 with pycnia on May 29, followed in a short time by many aecia. A collection from this region was sown on *Ribes Cynosbati* the preceding year by Arthur (Mycol. **4**: 13. 1912).

Puccinia on *Carex arctata* Boot. was sown on *Ribes oxyacanthoides* on June 2. Pycnia appeared abundantly on June 11. Aecia appeared but they did not flourish and only a few matured. Sowings were also tried on *Sambucus racemosa* and *Aster acuminatus* Michx. but without infection.

PUCCINIA CARICIS-SOLIDAGINIS Arth.

A collection on *Carex scoparia* Schk. was sown on *Solidago graminifolia* (L.) Salisb. on May 7 with pycnia May 25 and aecia on June 13. Arthur (Mycol. 4: 15. 1912) established this connection with teliosporic material collected in Maine.

A *Puccinia* on *Carex stipata* Muhl. heretofore called *Puccinia Peckii,* was sown on *Solidago* (*rugosa?*) on June 5 with very abundant pycnia on June 11, but the plants died soon after, so that the aecia did not mature. Strong field evidence of connection suggested the sowing. It seems from the culture and the field observations that the *Puccinia* on *Carex stipata* which has passed as *Puccinia Peckii* in this region belongs to *P. Caricis-Solidaginis.*

PUCCINIA ASTERIS-CARICIS Arth.

Teliosporic material from *Carex trisperma* L. was sown on *Aster acuminatus* Michx. on June 12 with pycnia on June 20 and aecia by July 1, both in great abundance. Another sowing on July 10 on the same host also gave abundant pycnia and aecia. This connection was supported by strong field evidence.

UROMYCES PERIGYNIUS Halst.

A collection of teliosporic material on *Carex deflexa* Hornem. was sown on *Solidago* (*rugosa?*) on May 25 with pycnia on June 1 and aecia on June 21. Another sowing on May 25 on *Solidago bicolor* L. gave pycnia on June 6 followed by aecia on June 21, both in abundance.

Another collection on *Carex scoparia* was sown on *Solidago graminifolia* (L.) Salisb. on May 28 with very abundant pycnial infection by June 6. The plants died in a few days, probably from the severe infection. The field evidence of the connection of these forms was as conclusive as such evidence could be.

A collection on *Carex intumescens* was sown on *Solidago* (species undetermined) successfully. Field evidence of connection suggested a sowing on *Aster* which was made on June 15, with very abundant pycnia on June 25 but the plants died in a few days later, probably from the severe infection, so that no aecia developed. The species of *Aster* was probably *puniceus,* but a certain determination could not be made.

These experiments tend to confirm the experiments of Arthur (Mycol. 4: 21. 1912) with this species and add another telial host, *Carex scoparia*, as anticipated.

NECIUM FARLOWII Arth.

This rust was found to occur abundantly during the summer of 1910 on the leaves and twigs of a number of trees of *Tsuga canadensis* that grew near Pictou. It was most common on trees from ten to fifteen feet in height and practically all the twigs at the top of the infected trees were killed by the fungus. The rusted leaves soon fell away but the twigs remained during the winter. Some of these twigs bearing telia were collected in the fall and wintered. Collections were also made from the trees in the spring, and both collections gave good germination in a moist chamber in a few days.

A sowing was made on *Tsuga canadensis* on June 5 and by the 14th the leaves began to turn yellow, indicating infection and telia were present by the 21st. No pycnia were formed. Another trial on June 11 gave telia by June 27 and a third on June 14 was also successful, the telia being first noticed on June 27. Telia began to form on the twigs a few days later than on the leaves.

The infected twigs that remained on the trees in the field were observed germinating on June 14 after a day or two of showery weather. The germinating telia could be easily recognized on close examination as they became reddish in color and swollen and velvety in appearance. Microscopic examination showed the promycelia to be rather large with spherical basidiospores 8–10 μ in diameter, of a deep reddish color. The young leaves in the vicinity of the germinating telia began to show infection by the first of July and well developed telia were collected on July 5. Infection of the twigs soon followed. The cones on the overhanging branches of a large hemlock also became infected, the first collection being made on July 8.

Arthur in NORTH AMERICAN FLORA regards this species as possessing telia only and possibly pycnia. These observations and experiments confirm this view and indicate that pycnia are absent.

MELAMPSOROPSIS PYROLAE (DC.) Arthur

The association of this rust with *Peridermium conorum-Piceae* (Rees) Arthur was discussed in a previous paper (Mycol. 3: 70. 1911). This season's experiments were carried on for the purpose of establishing the connection of these forms.

Three trees of *Picea mariana* (Mill.) BSP. were taken into the laboratory just when the cones were bursting the scales, and on May 26 plants of *Pyrola* bearing germinating teliospores were suspended above so that the basidiospores would fall on the cones. Two of the trees soon died, the third grew for a time and the cones developed. Pycnia were noticed on June 17, followed by the aecia of *Peridermium conorum-Piceae*. The aecial spores were being shed by July 16. Only one cone became infected, out of about fifteen that grew on the tree.

Experiments were also tried in the field. Two trees about fifty yards apart were selected in a grove of *Picea* on a point that juts into the harbor. The grove was surrounded on the landward side by cultivated fields and was a mile or more distant from any suspected source of infection. Plants of *Pyrola* bearing germinating teliospores were suspended on May 29 above the cones as in the experiment in the laboratory, provision being made to keep their roots moist. On June 26 the cones of both trees were covered with pycnia which probably appeared a week or more earlier, as only occasional visits were made to the place. Aecia were present by July 4 and the spores were being shed by July 8. One of the trees was *Picea mariana;* of the 21 cones that it bore, all but one were infected. There were 14 cones on the other tree (*Picea canadensis*), of which 9 were infected. The cones of the trees (*Picea*) that grew everywhere near were carefully examined and no infection was found in the vicinity or within more than a mile of the place where the experiments had been made. When the aecial spores are being shed the infected cones are conspicuous and not likely to be overlooked especially on small trees. Even the pycnial stage is also conspicuous as the scales turn yellow, and yellow-colored resin oozes freely from the cones. The most of the trees in the grove were small, not over 20 feet in height, but cones were plentiful. For convenience, the smallest trees with few cones were selected for the experiments.

The plants of rusted *Pyrola* used in the experiments were *Pyrola americana* Sweet and *P. elliptica* Nutt.

While the experiment in the laboratory cannot be regarded as conclusive owing to the scant infection and the remote possibility of the cones having been infected before the trees were taken in to the laboratory, yet the experiments in the field seem to the writer to show beyond reasonable doubt that *Peridermium conorum-Piceae* is the aecial stage of *Melampsoropsis Pyrolae.*

The poor infection in the laboratory experiments may have been due to the fact that the tree was not in a flourishing condition or that the provision made to keep the atmosphere moist about the cones was not sufficient, or, as the writer believes, to the cones not being old enough when the sowing was made. In the field experiments the cones were more mature. It was also found that *Pucciniastrum minimum* readily infected the cones of *Tsuga* when they were so far developed that infection was regarded as doubtful.

In the region where the *Pyrola* rust was collected, the teliospores began to germinate about May 24. The pycnia of *Per. conorum-Piceae* were noticed on the cones of *Picea mariana* in the vicinity on July 1, and the aecial spores were being shed on July 16. The *Peridermium* was rather rare, only a cone or two showing infection on the trees attacked, and in all only about two dozen cones were collected, where they could be collected in hundreds the preceding season.

PUCCINIASTRUM MINIMUM (Schw.) Arthur

During the summer of 1910, in a small area that had previously been swept by a fire, a very luxuriant growth of *Rhodora canadense* (L.) BSP. resulted, and on the leaves of the *Rhodora* a splendid development of the uredinia and telia of this rust was present. To gain some clue to the aecial stage, leaves were gathered in early spring and placed beneath small trees of *Abies canadensis* and *Tsuga canadensis* and small trees of the same species were planted among the rusted *Rhodora.* Trees of *Picea* grew near the *Rhodora,* so these were not experimented with. It was thought most probable that the aecial host was either *Abies* or *Tsuga.*

Leaves with telia were also collected and the teliospores were

germinated in a few days in a moist chamber. A sowing was made on *Abies balsamea* and *Tsuga canadensis* on June 13 with pycnia on the latter on June 20, and aecia on July 1, but without infection on the former. Another sowing on the same hosts on June 17 gave pycnia on *Tsuga canadensis* on June 26 and aecia on July 4 but without infection on *Abies*. A third sowing was made with the same results.

In the field the infected leaves of *Rhodora* had been placed under two trees of *Tsuga canadensis* in different places and in both there was a most decided infection of the neighboring leaves; the trees of *Tsuga* that had been planted among the rusted *Rhodora* also developed aecia, but *Abies* did not. The writer's attention was now called to Arthur's description of *Per. fructigenum* (Bull. Torrey Club **37**: 578. 1910) on the cones of *Tsuga ciniastrum minimum*, and also to Spaulding's collection of aecia on the leaves of the hemlock which he regarded as belonging to this species (Phytopath. **1**: 94. 1911). Experiments were now tried to determine if the cones could be infected.

As it was not practicable to take cone-bearing trees of *Tsuga canadensis* into the laboratory, branches with cones were placed in water and a fresh surface was exposed to the water every day or two by removing a small portion of the end of the twig. A sowing was made on the cones and leaves on June 18 with abundant pycnia on the cones and leaves on June 26. Aecia developed abundantly on the leaves by July 8 and a few aecia appeared on the cones a day or two later. Another sowing was made on June 22 with pycnia on the cones and leaves in abundance on July 2 and aecia on the leaves by July 8, also in abundance. Two or three days later a few aecia appeared on the cones.

About the same date, during a day or two of showery weather, leaves of the *Rhodora* with germinating telia were collected in the field and placed on the cones of a large tree of *Tsuga canadensis*. Some of the material was also thrown beneath and over a small tree of the same species. Pycnia appeared abundantly in about a week on the cones and leaves of both trees. There was also a most luxuriant development of aecia on the leaves, but only a few aecia matured on the cones.

Dr. Spaulding generously furnished material from his collec-

tions of *Peridermium fructigenum* Arth. for comparison, but it seemed to be distinct from the culture aecia. Several collections of aecia were made during the summer of 1910 and 1911 in various parts of the province on *Tsuga canadensis*. These collections were regarded by the writer as *Peridium Peckii* and the field evidence clearly indicated a connection with *Pucciniastrum Myrtilli* on *Vaccinium pennsylvanicum* and *V. canadense*. The culture aecia, both field and indoor, of *Pucciniastrum minimum* were so much paler in color than the aecia regarded as *Peridermium Peckii* that the writer was inclined to consider them distinct. Material was sent to Dr. Arthur for determination. He replied that the aecial form from *Pucciniastrum minimum* was *Peridermium Peckii* and the form that seemed to be connected with *Pucciniastrum Myrtilli* was distinct.

These cultures seem to the writer to prove that the aecia of *Pucciniastrum minimum* (Schw.) Arthur are on the leaves and cones of *Tsuga canadensis* and according to the determination of Dr. Arthur belong to *Peridermium Peckii* Thüm.

UROMYCES SPARTINAE Farl.

For three successive years aecia were collected on *Spergularia canadensis* (Pers.) Don near Pictou. The aecia seemed to be connected with *Uromyces Spartinae* on *Spartina patens* (Ait.) Muhl. and *S. glabra* var. *alterniflora*. Attempts were made, in the spring of 1910, to test this supposed connection by cultures, but the teliospores failed to germinate. On June 10, 1911, aecia were found to occur very abundantly on *Arenaria lateriflora* L. in several places, and in each the distribution of the aecia seemed to leave no doubt that they were connected with the *Uromyces* on *Spartina Michauxiana* Hitch. As abundant material of this rust on the three species of *Spartina* common in this region had been collected in early spring for use in culture work and was found to give good germination, experiments were tried to test the suspected connection.

A sowing of teliosporic material from *Spartina Michauxiana* was made on *Arenaria lateriflora* on June 11 with pycnia on June 17 and aecia on June 27, both in abundance on the young leaves and stem. Another sowing on June 12 gave pycnia on June 18

and aecia on June 27, also in abundance. Another sowing on June 27 gave pycnia on July 7 and aecia on July 16, but not in such abundance, probably owing to the maturity of the leaves. Three different sowings were made on *Spergularia canadensis* and one each on *Stellaria media* (L.) Cyrill., *S. graminea* L., and *Glaux maritima* L. without infection in any case.

Teliosporic material from *Spartina glabra* var. *alterniflora* was sown on *Spergularia canadensis* on June 12 with pycnia on June 20 and aecia on June 27. A previous sowing on the same host was successful, but the dates were not kept. Two sowings were made on *Arenaria lateriflora* without infection.

A sowing of teliosporic material from *Spartina patens* was made on *Spergularia canadensis* on June 12 with pycnia on June 20 and aecia on June 27. Two further sowings made, one on June 27 and the other on the 28th, were also successful, producing pycnia and aecia in due time. Two sowings were made on *Arenaria lateriflora* and one on *Salicornia europea* without infection.

The field observations and cultures show that *Uromyces Spartinae* on *Spartina Michauxiana* has aecia on *Arenaria lateriflora* but not on *Spergularia canadensis*, while the same rust on *S. patens and S. glabra* var. *alterniflora* has aecia on *Spergularia canadensis* and not on *Arenaria lateriflora*.

Dr. Arthur studied the field collections and culture material here described for vol. 7, part 3, of NORTH AMERICAN FLORA, which includes this species. His conclusions in regard to the position of this species can be gathered from his treatment of it in that work.

MELAMPSORA ARCTICA Rostr.

A species of *Caeoma* was found to occur abundantly on *Abies balsamea* during the early summer of 1910. A collection of the material was sent to Dr. Arthur, who suggested that it might be the aecial stage of *Melampsora arctica* Rostr. Field study confirmed this suggestion, as the willows in the neighborhood of the *Caeoma* soon developed uredinia and telia of *Melampsora artica* Rostr. Leaves with telia were collected in the fall and wintered and the teliospores gave good germination in a few days in a moist chamber. A sowing was made on *Abies balsamea* on May

27. Pycnia appeared on June 2 followed by aecia in a few days. Another sowing was made on two trees of the same host on May 30, with pycnia by June 3 and aecia by June 10. Two different sowings were made on *Larix laricina* (DuRoi) Koch but no infection followed. The willow from which the teliosporic material used in the experiments was obtained was determined as *Salix discolor* Muhl. by John Macoun. Collections were also made on *Salix rostrata* Richards.

The *Caeoma* was not so common in the summer of 1911 as in the previous season, probably owing to the dry weather, but the collections made were in the vicinity of willows that were infected with this rust the preceding year. It does not seem to have been previously collected. The pycnia are numerous, hypophyllous; the aecia hypophyllous, rather large and conspicuous; the aeciospores ovoid or globose, 13–16 × 15–24 μ; wall rather thick, 2–3 μ, finely verrucose; contents orange.

MELAMPSORA (MEDUSAE Thüm.?)

During the summer of 1910 several small hemlocks in the natural park at Truro, N. S., were observed to be so severely infected by *Caeoma Abietis-canadensis* Farl. that it suggested local infection. In the fall of the same year, the writer, in company with Professor H. W. Smith, of the Truro Agricultural College, visited the place and careful search was made for some clue to the telial stage. No rust was found in the vicinity, except a *Melampsora* on *Populus grandidentata* Michx., several trees of which grew near. This was regarded as *Melampsora Medusae* Thüm. and examination seemed to confirm this view. As the aecial stage of this rust has been shown to occur on *Larix*, the proximity of the poplar rust was thought to be of little significance.

Teliosporic material on *Populus grandidentata*, however, was collected near Pictou in the spring, and on June 9 sowings were made on *Larix laricina* and *Tsuga canadensis*. A few pycnia appeared on the *Larix* on June 25 but there was no further development, although the plants remained in good condition. Pycnia appeared on *Tsuga canadensis* on June 16 and aecia of the *Caeoma* type on June 25. Another sowing on *Tsuga canadensis* on June 19 gave pycnia on June 27 and aecia on July 4, and a

third sowing on June 21 gave pycnia on June 30 with aecia on July 8. Two more sowings were tried on *Larix laricina* without result.

The teliosporic material was collected from a grove of young poplars that were severely attacked by the *Melampsora* the previous season. A visit to the place showed that several young trees of *Tsuga canadensis* grew among the poplars and these were carefully watched for the appearance of aecia. Pycnia and aecia were first collected on June 19. A very rich infection of the trees of *Tsuga* in the immediate vicinity soon followed. The young trees about a foot in height, beneath which were many poplar leaves with the telia of the *Melampsora*, showed an exceedingly rich infection, practically all the leaves and many of the twigs being infected. The poplars were also watched and in due time the uredinia of the *Melampsora* appeared. The distribution was such that it indicated the source of infection to be the *Caeoma* on the *Tsuga*. Similar observations were carried out at Truro, but the place could not be visited often and the observations were not so complete. The observations and cultures leave no doubt in the mind of the writer that the *Melampsora* on *Populus* in the region studied by the writer has aecia on *Tsuga canadensis*, and that the aecia are *Caeoma Abietis-canadensis*. It seems probable that the species discussed is a form of *Melampsora Medusae* with aecia on *Tsuga canadensis*. The weak pycnial infection of *Larix* in one culture seems to support this view but further study is needed. The field collections of aecia were submitted to Dr. Arthur, who confirmed the determination.

A *Caeoma* was often collected in this region on *Larix laricina*. As there seem to be no good characters for separating the aecia of *Melampsora Medusae* and *M. Bigelowii*, both of which have been shown by cultures to occur on *Larix*, it was impossible to determine to which species these collections belonged. The field evidence, though not very strong, indicated that all the collections on *Larix* belonged to *Melampsora Bigelowii* Thüm.

PERIDERMIUM BALSAMEUM Peck

This *Peridermium* was found abundantly on *Abies balsamea* (L.) in all the regions of Nova Scotia visited by the writer.

Field observations made during 1910 seemed to point to *Pucciniastrum arcticum* on *Rubus* as the telial stage (Mycol. 3: 72. 1911). It was also noticed that *Uredinopsis mirabilis* (Peck) Magn. was associated in a very striking way with the same *Peridermium*, but it was not considered probable that they were related. However, as observations made during the early summer of 1911 seemed to point to their connection, a sowing of the *Peridermium* was made on a pot of *Onoclea sensibilis* on July 7. Uredinia were observed abundantly on July 16. At this date the filaments of urediniospores were oozing out. As the plants of *Onoclea* were grown from rhizomes taken into the laboratory in early spring, there was no chance for infection before the sowing. Later study, however, suggested that urediniospores may have been present on the *Onoclea* which grew beneath the *Abies* shoots used in the culture experiment, and that infection may have possibly come from urediniospores clinging to the leaves. It was some time after the appearance of the *Peridermium* that the collection was made for the culture, so that there was sufficient time for the urediniospores to appear on the ferns even if they developed from the aecia on *Abies*. No record was made at the time of collection of the presence of the fern rust, but later it was abundant on the *Onoclea* beneath the fir and may have been present at the time of collection of the aecia.

On July 17 another sowing was made on a number of plants of *Onoclea sensibilis* that had been obtained in the field on the same day. Uredinia appeared on all about July 25. One pot of plants kept as a check remained free from infection, but a few plants of *Onoclea* in the field alongside of those that were used for the culture showed uredinia on July 31. The possibility of the plants being infected before being taken into the greenhouse is not therefore excluded, so the experiment does not establish the connection of the *Peridermium* and the fern rust.

During the season the distribution of *Peridermium balsameum* and *Uredinopsis* on ferns was carefully studied in the field and their association was so marked that the writer concluded it could not be accidental. There was evidence to show that more species than one are included under this *Peridermium*. The first appearance of the aecia was during the last week of June and the

first weeks of July. These aecia appeared to be connected with *Uredinopsis mirabilis* on *Onoclea sensibilis.* A second crop appeared about the first of August and lasted during the month. These seemed to be connected with *Uredinopsis Osmundae* and *U. Phegopteridis.* There was a striking difference between the field appearance of the earlier and later aecia, and the spores of the former averaged about 8 μ smaller than the latter.

The writer is convinced that at least two forms are confused under *Peridermium balsameum* and that these are connected with *Uredinopsis* on ferns. It may be that one is also the aecial stage of *Pucciniastrum arcticum* on *Rubus.* There was considerable field evidence to support this view, but that does not seem probable. Preparations have been made to carry on further experiments next year, and the writer looks forward with confidence to throwing some light on the life history of the fern rusts so little understood at present.

Attempts were made to germinate the urediniospores of *Uredinopsis mirabilis* and with some success. Germ tubes emerged from germ pores, two placed near the beak and two near the base of the spore. The germ tube was that of the usual uredospore but very small. Two germ tubes only emerged from each spore on germination usually, one from the oppositely placed pores either at the apex or base, but sometimes both on the same side of the spore. Attempts were made to infect plants of *Onoclea sensibilis* with uredospores and the experiments were successful but opportunity was not given to follow the experiments carefully. The experiments indicated, however, that the first spore to appear in the fern rust is the uredospore and that it is functionally a uredospore.

PUCCINIASTRUM AGRIMONIAE (Schw.) Tranz

There was a very rich development of both the telial and uredinial stages of this rust on *Agrimonia gryposepala* Wallr. near New Glasgow for several years, but no clue to the aecial stage was noticed. All the conifers of the region grew among the rust except *Tsuga canadensis.* Repeated attempts were made to germinate teliosporic material from this place but without success. Leaves of the host were suspended above young trees of *Tsuga*

canadensis and *Abies balsamea* lest some germinating telia might have escaped detection but there was no result. Uredinia were collected on the young leaves of *Agrimonia* in May, and this would indicate that probably the rust is either carried over the winter by the urediniospores or is perennial in the rootstock or roots, as the young leaves of the conifers were not open at the time of the collection.

SUMMARY OF CULTURES DESCRIBED IN THIS ARTICLE

1. *Life histories supplementing previous work of the writer or other investigators*

Pucciniastrum pustulatum (Pers.) Dietel. Teliospores from *Epilobium angustifolium* L. infected *Abies balsamea* (L.) Mill. Aeciospores from *Abies balsamea* infected *Epilobium angustifolium* L.

Calyptospora columnaris (A. & S.) Kuehn. Teliospores from *Vaccinium pennsylvanicum* Lam. infected *Abies balsamea* (L.) Mill.

Melampsoropsis ledicola (Peck) Arthur. Teliospores from *Ledum groendlandicum* Oeder infected *Picea canadensis* (Mill.) BSP.

Melampsoropsis Cassandrae (Peck & Clinton) Arthur. Teliospores from *Chamaedaphne calyculata* (L.) Moench infected *Picea rubra* (DuRoi) Dietr. and *Picea mariana* (Mill.) BSP.

Melampsoropsis abietina (A. & S.) Arthur. Teliospores from *Ledum groendlandicum* Oeder infected *Picea rubra* (DuRoi) Dietr.

Uromyces Scirpi Burr. Teliospores from *Scirpus campestris* var. *paludosus* (A. Nelson) Fernald infected *Cicuta maculata* L.

Uromyces Peckianus Farl. Teliospores from *Distichlis spicata* (L.) Greene infected *Atriplex hastata* L., *Chenopodium album* L. and *Salicornia europea* L.

Uromyces perigynius Halst. Teliospores from *Carex deflexa* Hornem. infected *Solidago bicolor* L. Teliospores from *Carex scoparia* Schkuhr. infected *Solidago graminifolia* (L.) Salisb., and also *Aster* (*puniceus?*).

Puccinia perplexans Plow. Teliospores from *Alopecurus pratensis* L. infected *Ranunculus acris* L.

Puccinia albiperidia Arth. Teliospores from *Carex intumescens* Rudge, *Carex debilis* var. *Rudgei* Bailey, and *Carex crinita* Lam. infected *Ribes prostratum* L'Hér and teliospores from *Carex crinita* Lam. and *Carex arctata* Boot. infected *Ribes oxyacanthoides* L.

Puccinia Caricis-solidaginis Arth. Teliospores from *Carex scoparia* Schkuhr. infected *Solidago graminifolia* (L.) Salisb. and from *Carex stipata* Muhl. infected *Solidago* (*rugosa?*).

Puccinia Caricis-Asteris Arthur. Teliospores from *Carex trisperma* L. infected *Aster acuminatus* Michx.

2. Life histories worked out for the first time

Necium Farlowii Arth. Teliospores from *Tsuga canadensis* (L.) Carr. infected the same species.

Melampsoropsis Pyrolae (DC.) Arth. Teliospores from *Pyrola Americana* Sweet and *Pyrola elliptica* Nutt. infected cones of *Picea mariana* (Mill.) BSP. and *Picea canadensis* (Mill.) BSP. (*Peridermium conorum-Piceae* (Rees) Arthur).

Pucciniastrum minimum (Schw.) Arthur. Teliospores from *Rhodora canadense* (L.) BSP. infected leaves and cones of *Tsuga canadensis* (L.) Carr. (*Peridermium Peckii* Thüm.).

Uromyces Spartinae Farl. Teliospores from *Spartina Michauxiana* Hitch. infected *Arenaria lateriflora* L. but failed to infect *Spergularia canadensis* (Pers.) Don. Teliospores from *Spartina patens* (Ait.) Muhl. and *Spartina glabra* var. *alterniflora* (Loisel) Merr. infected *Spergularia canadensis* but failed to infect *Arenaria lateriflora* L.

Melampsora arctica Rostr. Teliospores from *Salix discolor* Muhl. infected *Abies balsamea* (L.) Mill.

Melampsora (*Medusae* Thüm.?) Teliospores from *Populus grandidentata* Michx. infected *Tsuga canadensis* (L.) Carr. (*Caeoma Abietis-canadensis* Farl.).

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CORRELATION BETWEEN CERTAIN SPECIES OF PUCCINIA AND UROMYCES[1]

C. R. Orton

(With Plates 70 and 71, Containing 12 Figures)

There are many interesting taxonomic problems which have arisen in the work of preparing the Uredinales for North American Flora. One of these problems, which has been supplemented somewhat by cultures and field observations, bears directly upon the relationship existing between *Puccinia* and *Uromyces*. To bring out one feature of this relationship more clearly than heretofore presented the writer has prepared this paper, pointing out certain species in the two genera which are conspicuous because of their apparent morphological similarity and of their occurrence upon the same or closely related hosts in both gametophytic and sporophytic stages. The similar geographical distribution of these correlated species appears in most cases to afford some additional support to this relationship.

A brief statement of the treatment of *Uromyces* and *Puccinia* by the leading workers on the rusts, from Persoon's time to the present, is here included for the purpose of a better understanding of the taxonomic development of these genera.

Persoon in 1794[2] was the first to publish any clearly defined work on fungi in which the Uredinales were included. In this work he brought forward the name *Puccinia*, a name first used by Micheli, a prebinomial author, and applied it to species of *Phragmidium* and those of other genera including three species of *Puccinia* as we now use that genus. In the same work the genus *Uredo* was established which contained four species now referable to as many genera. The second species was *Uredo Fabae* which is undoubtedly a *Uromyces*. In a later work[3] by the same

[1] Read before the American Phytopathological Society at the Washington meeting, Dec. 28, 1911.

[2] Neues Mag. Bot. 1: 93. 1794.

[3] Syn. Fung. 1: 220–230. 1801.

author there were three species now referable to the genus *Puccinia* included under that genus along with species representing at least three other genera, and under *Nigredo*, a name which he established as a subgenus of *Uredo*, there were several species which would now be referred to *Uromyces*.

The principal workers who followed Persoon were Schumacher in 1803, Willdenow in 1804, and DeCandolle in 1805. The last author made a slight variation from Persoon's classification in his admirable systematic work on the French flora.[4] He divided the genus *Puccinia* into three sections, the first of which included several species of *Phragmidium*. The second section contained 13 species, the majority of which are referable to *Puccinia* as now used. Under the third section, which he characterized as being similar to *Puccinia* but having one-celled spores, six species were listed all of which are now referred to *Uromyces*.

After DeCandolle came Link, who in 1809[5] established the genus *Caeoma* corresponding to *Uredo* of Persoon. It was divided into five sub-genera. Under the sub-genus *Caeomurus* he placed DeCandolle's third section of *Puccinia* with one-celled spores, now properly referred to *Uromyces*. In 1816[6] Link separated the genus *Phragmidium* from *Puccinia* under which it had been previously included and left under *Puccinia* several species now properly referred to this genus. In this same work *Caeoma* was changed to *Hypodermium* and *Caeomurus* to *Uromyces* but their generic relation to each other remained as in 1809. In 1825[7] he published his third important contribution, in which the rusts were classified under several genera which included *Caeoma*, *Puccinia*, *Triphragmium*, *Phragmidium*, *Podisoma*, and *Gymnosporangium*. There were 48 species listed under *Puccinia*, practically all of which are now referable to that genus. *Caeoma* was divided into four sub-genera, namely: *Uredo*, *Aecidium*, *Ceratitium* and *Peridermium*. The first contained 113 species many of which were probably in the uredinial stage. There appears to be no disposition of species belonging to *Uromyces* except under this sub-genus.

[4] Flora Francaise **2**: 218–236. 1805.
[5] Ges. Nat. Freunde Berlin Mag. **3**: 6. 1809.
[6] Ges. Nat. Freunde Berlin Mag. **7**: 28–30. 1816.
[7] Willd. Sp. Plant. **6**[2]. 1825.

Link's 1816 classification was followed by Nees in 1817 and by S. F. Gray in 1821. Later came a series of authors, Schweinitz, Wahlenberg, Castagne, Léveillé and the Tulasnes, who in their disposition of *Uromyces* followed the methods of no one author but who endeavored to follow the combined good points of Persoon, DeCandolle and Link, which resulted in general confusion.

It remained for Fries,[8] the "Father of Mycology," to take up in 1846 the name *Uromyces,* which had been technically established as a genus by Unger[9] in 1833, and to place it in its present generic use. He made the noteworthy statement "Plurimae Pucciniae analogae respondent," a fact which none of the later urediniologists have refuted, and one which touches closely upon the subject of this paper. Schroeter[10] clearly brings out this analogous relation when he divides the genus *Uromyces* into biologic forms as eu-, brachy-, -opsis, micro-, and lepto-, in exactly the same manner as he did with the genus *Puccinia.*

Magnus[11] has called attention to the close morphological relationship existing between *Puccinia* and *Uromyces* on species of *Rumex* and has shown that in these species the urediniospores of the two genera intergrade in size and germ-pore characters on different species of host plant so that it is difficult to separate them in the uredinial generation.

Fischer in 1904[12] pointed out that a closer relationship existed between certain species of the genera *Puccinia* and *Uromyces* than existed in either genus alone, a fact which Arthur also observed and commented on in his "Classsification of the Uredinales."[13] Later in an article on "Reasons for Desiring a better Classification of the Uredinales"[14] Arthur calls them "parallel genera" differing only in the technical character of their teliospores.

McAlpine in his fine work on "The Rusts of Australia"[15] in speaking of *Puccinia* says: "The presence of mesospores in a

[8] Summa Veg. Scand. 1: 514. 1846.

[9] Exanth. Pfl. 277. 1833.

[10] Abh. Schles. Ges. **48**: 8–11. 1869. Schroeter in Cohn, Krypt. Flora Schles. 3^1: 229–313. 1887.

[11] Abh. Bot. Brand. **38**: 11–14. 1896.

[12] Beitr. Krypt. Schweiz. 2^2: xlvi. 1904.

[13] Result. Sci. Congr. Bot. Vienne 334. 1906.

[14] Jour. Myc. **12**: 150–151. 1906.

[15] The Rusts of Australia 26. 1906.

species would seem to indicate its still close relationship to *Uromyces*, and that its separation from the parent form has not yet proceeded sufficiently far to obliterate every trace of its former connexion."

Hariot in his "Les Uredinees"[16] says that the autonomy of *Uromyces* is a difficult question and that if it is to be kept as a distinct genus it is only in order to follow the custom and to facilitate determinations. This statement seems very much to the point, but the author does, however, treat the two genera as distinct in this work.

P. & H. Sydow in their monograph of *Uromyces*[17] state that the genus differs from *Puccinia* only in the number of cells in the teliospore, and they cite several comparative examples of both the gametophytic and sporophytic generations of the two genera to show this similarity.

It is seen, then, that the name *Puccinia* was first applied to a *Gymnosporangium* by Micheli, was later applied by Persoon to *Phragmidium* with which a few species of *Puccinia* were included, and was in 1816 separated by Link from *Phragmidium* and made a genus as we now use it.

The species of rusts now referable to the genus *Uromyces* were first included by Persoon and his followers under *Uredo*. Later it was included as a sub-genus of *Puccinia* by DeCandolle, and was finally established technically as a genus by Unger in 1833 and put into general use by Fries in 1846. Since Fries' work all uredinologists have treated it as a distinct genus differing from *Puccinia* especially in its teliosporic character.

The present paper is what the writer believes to be the first attempt to list the correlated species in *Puccinia* and *Uromyces* and is limited to a discussion of a few of the more prominent types of correlation in the long-cycle forms only.

The writer acknowledges the generous aid and counsel of Dr. J. C. Arthur, without which the work would be impossible, and grateful thanks are due Dr. F. D. Kern for many helpful suggestions.

The first example to attract special attention was furnished by

[16] Les Urédinées 20. 1908.

[17] Monog. Ured. 2: vi–xi. 1909.

Mr. W. P. Fraser[18] of Pictou, Nova Scotia, when he made sowings in the spring of 1910 of teliospores of *Uromyces Peckianus* Farlow on *Atriplex patula* and *Chenopodium album,* both of which produced infection and formed aecia of the same type as those of *Puccinia subnitens* Diet. on the same hosts. This extremely interesting result led to a careful comparison of the two rusts with results as follows: *Puccinia subnitens* Diet., is a rust on *Distichlis spictata* (L.) Greene and has its aecia on a large number of Chenopodiaceous, Capparidaceous and Cruciferous hosts,[19] which include *Atriplex, Beta, Cleome, Capsella, Chenopodium, Lepidium, Sarcobatus,* etc. The aecia are grouped and have erect peridia with peridial cells rhomboidal and in radial sections much thickened in the outer wall. On comparing the aecia of *Uromyces Peckianus* it was found that they were identical in all discernible morphological characters. The chief interest, however, lies in a comparison of the urediniospores, the morphology of which has been of greatest use in the study of the grass and sedge rusts. The urediniospores of *Puccinia subnitens* measure 18–24 by 19–26 μ, are pale cinnamon-brown with a wall about 2 μ thick, very finely verrucose, the pores 6, scattered. The urediniospores of *Uromyces Peckianus* measure 16–21 by 18–24 μ, are pale cinnamon-brown with a wall about 2.5 μ thick, very finely verrucose, and have 6 scattered pores. The teliospores of the two rusts possess no differential characters except, of course, number of cells and consequent size.

The distribution of the two is interesting. The telial host of both, *Distichlis spicata* (L.) Greene, grows in salt marshes on the Atlantic and Pacific coasts and in saline soil in the interior. *Uromyces Peckianus* is known only from the coastal regions while *Puccinia subnitens* on the other hand is an interior form having been collected at only one point on the coast and that at Lewes, Delaware. The reason for this is speculative at present, but it seems probable that the one-celled form is less adaptive to varying conditions of soil and temperature than the two-celled form and so has thus far been unable to thrive in the interior.

[18] Mycologia **3**: 72–74. 1911.

[19] Bot. Gaz. **35**: 19. 1903; Jour. Myc. **11**: 55. 1905; **12**: 16. 1906; **13**: 197. 1907; **14**: 15. 1908; Mycologia **1**: 234. 1909; **2**: 225, 1910: **4**: 18. 1912; **4**: 54. 1912.

The next species to attract particular attention and which are undoubtedly correlated are a *Puccinia* passing under several names (*P. Caricis-Asteris, P. Caricis-Solidaginis, P. Caricis-erigerontis*) on various species of *Carex,* having aecia on *Aster, Solidago, Erigeron,* and close relatives,[20] and *Uromyces perigynius* Hals. (*U. caricina* E. & E.) on several species of *Carex* which is known to have its aecia on *Solidago* and *Aster*.[21] The aecia of the two species appear identical and a careful microscopical study reveals that the peridial cells and aeciospores cannot be differentiated. The urediniospores of the *Puccinia* measure 14–19 by 18–24 μ, are light cinnamon-brown with a wall about 1.5 μ thick, moderately echinulate and have 2 superequatorial pores. A comparison of the urediniospores of *Uromyces perigynius* shows that they are identical in all their characters with the *Puccinia* form. The teliospores of the two species also possess identical characters except number of cells, having thin walls and rather thick apices. The distribution of the two is practically the same, extending across the northern half of the United States and into Canada. Three of the telial hosts, *Carex intumescens* Rudge, *C. scoparia* Schk., and *C. tribuloides* Wahl. are the same for both species.

A rust on species of *Andropogon, Puccinia Ellisiana* Thüm., has been in cultures[22] four different years on various hosts without success. It is a form widely distributed throughout the United States east of the Rocky mountains and in Mexico, and had puzzled us much until Dr. J. F. Brenckle, of Kulm, North Dakota, wrote on June 5, 1911, that he had found aecia on *Viola* near *Puccinia Ellisiana.* In a later communication he mentioned evidence to verify this probable connection. The suggestion seems very likely for in the Arthur Herbarium there are collections of aecia on *Viola* within the range of this rust which are out of the range of the *Uromyces* on *Andropogon* and which have peridial cells and aeciospores that are clearly differentiated, when carefully compared microscopically, from the autoecious rusts on *Viola.* On a careful study of *Puccinia Ellisiana* we find that

[20] Jour. Myc. **8**: 53–54. 1902; Bot. Gaz. **35**: 15, 21. 1903; Jour. Myc. **11**: 58. 1905; **12**: 15. 1906; **14**: 13. 1908; Mycologia **1**: 233. 1909; **2**: 224. 1910.

[21] Mycologia **4**: 21. 1912.

[22] Jour. Myc. **14**: 10. 1908; Mycologia **1**: 231. 1909; **2**: 220. 1910; **4**: 9. 1912.

it is apparently correlated with *Uromyces pedatatus* (Schw.) Sheldon. It has urediniospores which measure 18–20 by 19–23 μ, with walls about 3 μ thick, usually slightly thicker above, very finely and closely verrucose-echinulate, and have 4 or sometimes 3 equatorial pores. The urediniospores of *Uromyces pedatatus* possess no differential characters from those of *Puccinia Ellisiana* and have the same number and arrangement of pores. The teliospores of the two have the same general shape and wall thickness and so we venture to predict that Dr. Brenckle's observations are entirely correct and that *P. Ellisiana* has *Viola* for its aecial host.[23] The telial hosts of *Uromyces pedatatus* are restricted so far to *Andropogon glomeratus* (Walt.) BSP. and *A. virginicus* L. with a range extending from the Atlantic coast to Arkansas and southward, while the telial hosts of *Puccinia Ellisiana* include in addition to those of *U. pedatatus*, *Andropogon furcatus* Muhl. and *A. scoparius* Michx. with practically the same southern range but extending further north into North Dakota and west to Colorado. Here we see the greater adaptability of the two-celled form in a wider range of hosts and distribution.

In 1901, Dr. Arthur[24] connected a rust on *Carex pubescens* with an aecium on *Ribes Cynosbati* L. which possessed in culture a white or very pale peridium in contrast to the usual orange-colored aecial forms on various species of currants and gooseberries. He named the rust *Puccinia albiperidia*. In 1910 it was found that the original telial host as well as several other telial hosts represented in the herbarium, part having been reported in cultures,[25] possessed urediniospores with the marked morphological character of one basal pore, and it was decided that *P. albiperidia* was a good morphological species having its aecia on *Ribes* spp. Very recently, however, it has been found that in the type material and in every case where the species has been cultured on *Ribes* urediniospores in more or less abundance could be found which were morphologically identical with the urediniospores of the common gooseberry-currant rust of Europe and America.

[23] Since the writing of this paper it has been communicated to the writer through Dr. F. D. Kern that Mr. W. H. Long reports having cultured a *Puccinia* from *Andropogon* upon *Viola*. Doubtless this was *Puccinia Ellisiana*.

[24] Jour. Myc. **8**: 53. 1902.

[25] Jour. Myc. **10**: 11. 1904; Mycologia **4**: 13. 1912.

This discovery has led to the conclusion that the common form has been responsible for the successful cultures upon *Ribes* of this particular rust bearing the name *P. albiperidia* and that the rust having urediniospores with one basal pore is an unconnected form without a name. In order to discuss more readily this particular species I hereby propose the following name for it:

Puccinia uniporula sp. nov.

Urediniospores broadly ellipsoid, 16–23 by 25–29 μ, wall 1.5–2 μ thick, with only one pore placed near the hilum. Telia hypophyllous, scattered, roundish or oblong, 0.2–0.7 mm. long, early naked, pulvinate, dark cinnamon-brown. Teliospores broadly clavate, 15–20 by 34–48 μ, apex thickened up to 10 μ. Pedicel about once the length of spore or less.

The type is on *Carex pubescens* Muhl., collected at London, Canada, August 20, 1910, by J. Dearness. It has also been detected on six other species of *Carex*, and occurs sparingly from Newfoundland to Iowa.

In 1910, Dr. F. D. Kern[26] published the species *Uromyces uniporulus* on *Carex tenuis*, which has broadly ellipsoid urediniospores measuring 18–21 by 21–26 μ, with cinnamon-brown walls about 1.5 μ thick, rather sparsely and distinctly echinulate, and having one basal pore. The telial hosts of this rust are *Carex gracillima* Schw. and *C. tenuis* Rudge, both of which are hosts of *Puccinia uniporula*. The distribution of this species is now known locally from the New England states to Wisconsin. The aecial host of *Uromyces uniporulus* is unknown but it is undoubtedly the same as that of *Puccinia uniporula*.

The rusts on *Spartina* have been studied considerably in the past and three forms of *Uromyces* which variously intergrade have been separated, having aecia on members of the *Caryophyllaceae, Primulaceae,* and *Polemoniaceae* respectively.[27] The form of *Uromyces acuminatus* Arth., having aecia on *Steironema ciliatum* (L.) Raf. and telia on *Spartina gracilis* Trin. and *S. Michauxiana* Hitch. possesses urediniospores which are globoid, meas-

[26] Rhodora **12**: 125. 1910.

[27] Jour. Myc. **12**: 24. 1906; **13**: 193. 1907; **14**: 17. 1908; Mycologia **2**: 221. 1910; **4**: 29. 1912.

uring 23–26 by 26–30 μ, wall golden-yellow, 2–3 μ thick, very finely and sparsely echinulate, the pores being 8 scattered. *Puccinia Distichlidis* E. & E. was erroneously described as on *Distichlis maritima* Raf., the host being *Spartina gracilis* Trin. This rust has urediniospores whach are globoid, measuring 23–26 by 26–30 μ are golden-yellow with a wall 3–3.5 μ thick, very finely and sparsely echinulate, the pores being 8 scattered. The teliospores of the two rusts possess the close resemblanc of correlated forms. The distribution of the two-celled form extends from Iowa northwest to Wyoming and Montana, and of the one-celled form from Illinois west to Colorado and north to Alberta. The telial hosts of the two forms are the same. *Puccinia Distichlidis* has been cultured[28] on 21 different aecial hosts without success but not on the aecial host of *Uromyces acuminatus*. It seems, therefore, extremely probable that its aecial host is on some member of the primrose family, perhaps *Steironema*, or some member of the phlox family, but more likely the former.

Another evident case of correlation exists between *Puccinia Pammellii* (Trel.) Arth. and *Uromyces graminicola* Burr. In 1904, Dr. Arthur reported the cultures[29] of *Puccinia Panici* Diet. as the rust on *Panicum virgatum* was then called, upon *Euphorbia corollata* L. This rust has globoid urediniospores, measuring 19–23 by 21–24 μ, with a light cinnamon-brown wall about 2 μ thick, finely verrucose-echinulate, the pores are 3 or 4, usually approximately equatorial, but often scattered. The teliospores are small, somewhat thickened and rounded above.

Uromyces graminicola Burr. also on *Panicum virgatum* L. has been cultured[30] on 19 various hosts without success but never on *Euphorbia* to the writer's knowledge. It has globoid urediniospores measuring 15–19 by 18–23 μ which have all their other characters identical with those of *Puccinia Pammellii*. The teliospores of these forms have the same morphological resemblance which is expected in correlated species. *Puccinia Pammellii* has a distribution from Pennsylvania west to Nebraska and south to the Gulf of Mexico and *Uromyces graminicola* has practically the

[28] Mycologia 2: 219, 1910; 4: 11, 1912.
[29] Jour. Myc. 11: 56. 1905.
[30] Jour. Myc. 12: 13. 1906; Mycologia 1: 232. 1909; 4: 12. 1912.

same distribution. It seems very probable, therefore, that this one-celled form has aecia of the same character as those connected with *Puccinia Pammellii* and on an upright form of *Euphorbia.*

Several other examples have been observed which have for their telial hosts identical or closely related species of the same genus, only a mention of which is made here. Among the heteroecious forms the following have been noted:

1. *Puccinia Eleocharidis* Arth. with *Uromyces Eleocharidis* Arth., both on *Eleocharis* spp., the *Puccinia* having aecia on *Eupatorium perfoliatum.*

2. *Puccinia angustatoides* Stone with *Uromyces Rhynchosporae* Ell., both on *Rhynchospora* spp.

The following autoecious species present the same striking correlation in all their spore forms as do the heteroecious species:

1. *Puccinia heterantha* Ell. & Ev. with *Uromyces plumbarius* Peck, both on several representatives of the Onagraceae.

2. *Puccinia Gentianae* (Str.) Link with *Uromyces speciosus* Holw. on *Gentiana* spp.

3. *Puccinia Ruelliae-Bourgaei* Diet. & Holw. with *Uromyces Ruelliae* Holw. on *Ruellia* spp.

4. *Puccinia opaca* Diet. & Holw. with *Uromyces cucullatus* Sydow both on *Zexmenia* spp.

There are a few slight comparative differences worthy to be noted in a careful study of these correlated species. From a comparison of accurate measurements of a large number of urediniospores it is found that those of the *Puccinia* species are usually slightly larger and have thicker walls than those of the correlated *Uromyces* form. There is also sometimes noticed a marked difference in the vigor of the two forms, the *Puccinia* being the more vigorous in its attack upon the host plant. These differences, however, only mean that the genus *Puccinia* has a greater adaptability to environmental conditions and seems better fitted to survive than the less vigorous form. This is also brought out in the preponderance in numbers of species in the genus *Puccinia* as compared to the number in the genus *Uromyces.*

There are many correlated species among the long-cycle forms of *Puccinia* and *Uromyces* which are not mentioned in this paper.

Many southern and western species are but imperfectly understood and lack of time has prevented a careful study of some of the forms already fairly well known. It should not be inferred that every species of *Puccinia* has a correlated form in *Uromyces*. Correlation does occur frequently however, and appears not to be confined to any particular family or order of hosts, although it seems to be most common on the grasses and sedges. The reasons for these limitations appear to lie in a solution of the conditions surrounding the evolution of the rusts and their hosts, and any knowledge concerning the evolution of host and parasite undoubtedly has a close bearing upon the solution of this phase of the problem.

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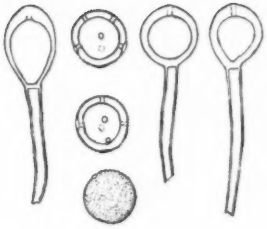
EXPLANATION OF PLATES LXX AND LXXI

The drawings were outlined with the camera lucida at a uniform scale, the reproductions representing approximately 470 diameters. In all cases the urediniospores are represented with the hilum, or attachment of pedicel, below. The urediniospores are drawn to show thickness of wall, surface markings and position and number of germ pores. The teliospores are drawn to show thickness of wall and apex, and the average length of pedicel.

Fig. 1. *Puccinia subnitens* on *Distichlis spicata.*
Fig. 2. *Uromyces Peckianus* on *Distichlis spicata.*
Fig. 3. *Puccinia Caricis-Asteris* on *Carex tribuloides.*
Fig. 4. *Uromyces perigynius* on *Carex intumescens.*
Fig. 5. *Puccinia Ellisiana* on *Andropogon furcatus.*
Fig. 6. *Uromyces pedatatus* on *Andropogon virginicus.*
Fig. 7. *Puccinia uniporula* on *Carex pubescens.*
Fig. 8. *Uromyces uniporulus* on *Carex gracillima.*
Fig. 9. *Puccinia Distichlidis* on *Spartina gracilis.*
Fig. 10. *Uromyces acuminatus* on *Spartina gracilis.*
Fig. 11. *Puccinia Pammellii* on *Panicum virgatum.*
Fig. 12. *Uromyces graminicola* on *Panicum virgatum.*

1



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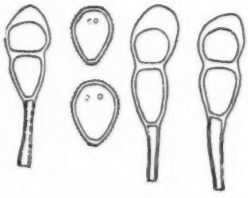

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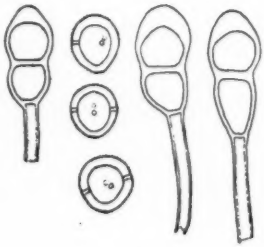

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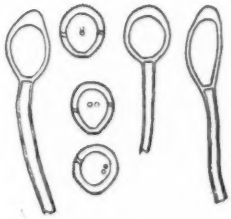

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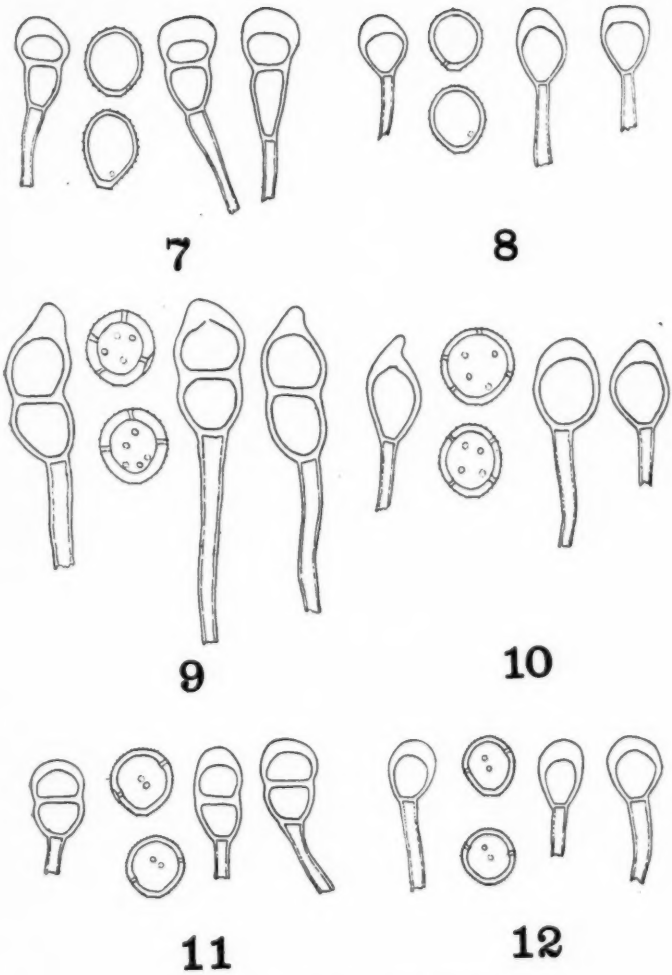
SPORES OF PUCCINIA AND UROMYCES



SPORES OF PUCCINIA AND UROMYCES

THE AGARICACEAE OF THE PACIFIC COAST—I

WILLIAM A. MURRILL

A list of the pileate polypores and boletes collected by the writer on the Pacific coast in 1911 appeared in MYCOLOGIA for March, 1912, together with a descriptive list of the localities visited at that time. The present series of articles is more comprehensive in scope, including all the gill-fungi known to exist in California, Oregon, Washington, British Columbia, and Alaska, as represented in the collections of McClatchie, Dudley, Trelease, Baker, Abrams, Harper, McMurphy, M. E. Peck, Lake, Zeller, and others. Naturally, the extensive collections and field studies made by the writer in 1911 will be used as the basis of these articles.

The Pacific Coast is the fifth distinct region in which the writer has been interested so far as the fleshy fungi are concerned. The northeastern United States have many species in common with Europe and a fair knowledge of European species is necessary to the student of this section. Also, a number of prevailing types circle the globe in temperate regions and extend southward along the mountains. The southern United States show a large number of distinct species which may well be studied as a group, although northern species are not rare and some tropical species occur there. As already stated in previous articles, the gap between tropical and temperate American species is comparatively wide and abrupt, although a few northern species are to be expected in the high mountains of our tropical islands, probably owing to former connections with the mainland.

The region of the Pacific coast is of exceeding interest, and has been so during recent geologic time, since the differentiation of the seasons. It differs more from the eastern United States in many respects than the eastern United States differ from northern Europe, which is explained by former land connections with Europe by way of Greenland. The difference in the fungi is not

that abrupt one noticed in the change to tropical America, where important temperate genera are wholly lacking, but it is rather a case of the same or similar genera represented largely by different species from those found east of the Rocky Mountains.

Tribe CHANTERELEAE

1. DICTYOLUS Quél. Ench. Fung. 139. 1886

DICTYOLUS RETIRUGUS (Bull.) Quél. Ench. Fung. 140. 1886

Chanterel bryophilus Peck, Harriman Alaska Exp. Crypt. 46. 1904. Not *C. bryophilus* Fries, Syst. Myc. 1: 325. 1821.

Muir Glacier, Alaska, *Trelease 552, 563;* Stanford University, California, *Baker.*

2. CHANTEREL Adans. Fam. Pl. 2: 11. 1763

1. CHANTEREL BEHRINGENSIS Berk. & Curt. Proc. Am. Acad. 4: 119. 1858

Bering Strait, Alaska, *Wright.*

2. CHANTEREL INFUNDIBULIFORMIS (Scop.) Fries, Epicr. Myc. 366. 1838

This species was found to grow very abundantly most of the year in a peat bog in the vicinity of Seattle among sphagnum and cranberry. The pileus is avellaneous and the stipe dull-luteous in fresh plants.

Seattle, Washington, *Murrill 273.*

3. CHANTEREL FLOCCOSUS Schw. Trans. Am. Phil. Soc. II. 4: 153. 1832

Corvallis, Oregon, *Murrill 1014;* Salem, Oregon, *M. E. Peck.*

4. CHANTEREL ALECTOROLOPHOIDES (Schaeff.) Murrill, N. Am. Fl. 9: 169. 1910

Seattle, Washington, *Murrill 669, Zeller;* La Honda, California, *Murrill & Abrams 1276;* British Columbia, *A. I. Hill 62.*

5. CHANTEREL CHANTARELLUS (L.) Murrill, N. Am. Fl. 9: 169. 1910

I found it difficult to believe that this was the same plant I had seen so often in Europe and the eastern United States. It grows much larger, is often compound and proliferous, and the hymenium becomes exceedingly complicated as it develops. The flesh is white and mild to the taste, and is very probably edible. Its size and abundance should make it an important article of food if it proves to be as wholesome as the eastern form.

Seattle, Washington, *Murrill 294, 363, 677, Zeller 1;* Corvallis, Oregon, *Murrill 1024,* Newport, Oregon, *Murrill 1026, 1050;* Berkeley, California, *Harper 5,* Stanford University, California, *Nohara 59.* Searsville Lake, California, *McMurphy 34.*

Tribe LACTARIEAE

This tribe, containing the genera *Russula* and *Lactaria,* will be treated in a separate article by Dr. Gertrude S. Burlingham.

Tribe AGARICEAE

Sporophore terrestrial, rarely wood-loving, fleshy throughout, centrally stipitate; spores white.	
Lamellae waxy at maturity, translucent or watery in appearance.	
Veil absent; pileus usually bright-colored.	1. HYDROCYBE.
Veil present; pileus rarely bright-colored.	2. HYGROPHORUS.
Lamellae not waxy, but having that appearance.	3. LACCARIA.
Lamellae neither waxy nor appearing waxy; veil present.	
Lamellae adnate.	4. ARMILLARIA.
Lamellae free.	5. LIMACELLA.
Sporophore wood-loving, with stipe eccentric, lateral, or wanting; spores white.	
Lamellae split longitudinally.	6. HYPONEVRIS.
Lamellae not split.	
Pileus sessile, tough, reviving, with a gelatinous upper stratum.	7. RESUPINATUS.
Pileus fleshy, not reviving, context homogeneous.	
Pileus dimidiate or resupinate.	8. GEOPETALUM.
Pileus stipitate.	
Veil wanting.	9. CREPIDOPUS.
Veil present.	10. PLEUROTUS.

1. HYDROCYBE (Fries) Karst. Hattsv. 233. 1879

1. HYDROCYBE CONICA (Scop.) Karst. Hattsv. 236. 1879

Abundant among mosses in open coniferous barrens about Seattle. All stages of color were observed from miniatous or

orange to greenish and blackish, becoming darker on drying. In Oregon, plants were found over 13 cm. high.

Seattle, Washington, *Murrill 520,* Tacoma, Washington, *Murrill 724;* Mill City, Oregon, *Murrill 795;* Portola, California, *McMurphy 55;* British Columbia, *A. I. Hill 16, 53.*

2. HYDROCYBE COCCINEA (Schaeff.) Karst. Hattsv. 234. 1879

Hygrophorus coccineus (Schaeff.) Fries, Epicr. Myc. 330. 1838.

Determined by Harper from fresh material. Spores ellipsoid, papillate at the side of the base where attached, hyaline with a slightly yellowish tint, 8–10 × 5–6 μ.

Muir Woods, California, *Harper 61;* Kings Mountain, California, under redwoods, *Dudley 164.*

3. **Hydrocybe constans** sp. nov.

Pileus convex, slightly umbilicate, gregarious, 1.5 cm. broad; surface glabrous, shining, not viscid, uniformly red, unchanging on drying, striate from the margin half way to the center; lamellae adnate with decurrent tooth, rather distant, plane or arcuate, testaceous-flavous; spores ellipsoid, smooth, hyaline, 7 × 4 μ; stipe hollow, subequal, smooth, glabrous, concolorous above, ochraceous at the base, 7 cm. long, 5 mm. thick.

Type collected in moss in low woods at Mill City, Oregon, November 9, 1911, *W. A. Murrill 814.* This species resembles *Hygrophorus miniatus* Fries in its form and brilliant red coloring, but does not fade on drying.

4. **Hydrocybe arenicola** sp. nov.

Pileus convex to slightly depressed, gregarious, reaching 7.5 cm. broad; surface sticky but not slimy, smooth, glabrous, melleous, with a ferruginous-ochraceous tint as the plants become older, usually blackish at the center; lamellae short-decurrent, arcuate to plane, venose-connected, distant, thin, whitish to cremeous, flavous on drying; spores ovoid, tapering at one end, smooth, hyaline, 7 × 4 μ; stipe subequal, sticky, smooth, glabrous, pale-melleous, hollow, 5 cm. long, 1.5 cm. thick.

Type collected on the ground in sandy pine barrens on the immediate coast at Newport, Oregon, November 13, 1911, *W. A. Murrill 1049.*

5. **Hydrocybe cremicolor** sp. nov.

Pileus convex to expanded, umbonate, solitary, 2.5 cm. broad; surface moist, not viscid, glabrous, smooth, uniformly cream-colored; lamellae decurrent, arcuate, distant, bright yellowish-white; spores ovoid, pointed at one end, smooth, hyaline, 5–6 × 3.5–4 μ; stipe fleshy, subequal, smooth, glabrous, cremeous, 5 cm. long, 7 mm. thick.

Type collected on the ground in woods at Seattle, Washington, October 20–November 1, 1911, *W. A. Murrill 568.* Plants collected at Berkeley, California, *Harper 30,* appear to agree with this species in the main, but are 4 cm. broad, slightly depressed, and the spores are ovoid, not pointed, 7 × 4 μ.

2. HYGROPHORUS Fries, Gen. Hymen. 8. 1836

1. HYGROPHORUS EBURNEUS (Bull.) Fries, Epicr. Myc. 321. 1838.

One of the most common and abundant species on the Pacific coast. In many localities, I could have gathered a basketful in a very small area. It is edible, and may be recognized by its white color, slimy covering, mild odor, and decurrent, distant gills.

Mill City, Oregon, *Murrill 832,* Corvallis, Oregon, *Murrill 887,* Salem, Oregon, *M. E. Peck;* Marin Co., California, *Miss Eastwood,* Mt. Tamalpais, California, *Miss Eastwood,* Berkeley, California, *Harper 18,* Stanford University, California, *McMurphy 139, Baker 138,* Searsville Lake, California, *McMurphy 58.*

2. **Hygrophorus variicolor** sp. nov.

Pileus rather thick and fleshy, convex to nearly plane, sometimes umbonate, solitary, 5–12 cm. broad; surface smooth, the center moist, subviscid, and glabrous, the margin dry and hispid-scaly, color varying from fulvous at the center to ferruginous-fulvous between center and margin, and stramineous on a marginal zone 1–5 cm. broad; lamellae squarely adnate, somewhat decurrent in large plants, subdistant, inserted, white, waxy, changing to reddish-brown on drying; spores ovoid, smooth, hyaline, 6–8 × 4–4.5 μ; stipe fleshy, subequal, white, pulverulent, 4 cm. long, nearly 1 cm. thick; veil represented by a few short, brownish fibrils at the center of the stipe.

Type collected on the ground in low woods, near Mill City, Oregon, November 9, 1911, *W. A. Murrill 802.* Also collected

in woods near Seattle, Washington, October 20–November 1, 1911, *W. A. Murrill 352, 400, S. M. Zeller 12.* A very beautiful species, related to *Hygrophorus Laurae* Morgan.

3. **Hygrophorus fragrans** sp. nov.

Pileus convex to depressed, not umbonate, gregarious, decidedly fragrant when dry, 8–10 cm. broad; surface smooth, glabrous, viscid, roseous to incarnate, with white margin and somewhat darker center; context rather thick and fleshy, white; lamellae adnate, distant, inserted, white; spores ellipsoid, smooth, hyaline, averaging $8 \times 5\mu$; stipe long, equal, solid, furfuraceous, whitish to cremeous or ochraceous, punctate with reddish-brown dots in dried specimens and turning reddish-brown where handled, reaching 10 cm. long and 2 cm. thick.

Type collected in low coniferous woods near Corvallis, Oregon, November 6–11, 1911, *W. A. Murrill 1009.* The punctate stipe reminds one of *Hygrophorus rubropunctatus* Peck.

4. **Hygrophorus subpustulatus** sp. nov.

Pileus fleshy, rather thin, convex, obtusely umbonate when young, solitary or gregarious, 2.5–5 cm. broad; surface very viscid-slimy, especially when young, whitish-avellaneous, sometimes varying to white on the margin, smooth, glabrous; lamellae squarely adnate, rarely slightly decurrent, plane, distant, inserted, white; spores ovoid, smooth, hyaline, $7–8 \times 4–6\mu$; stipe white throughout, equal, pruinose above, stuffed, about 7 cm. long and 1 cm. thick.

Type collected on the ground in woods near Seattle, Washington, October 20–November 1, 1911, *W. A. Murrill 317.* Also collected on November 7, 1911, at Glen Brook, Oregon, *W. A. Murrill 777,* and on November 9, 1911, at Mill City, Oregon, *W. A. Murrill 861.* The plants listed under *Hygrophorus limacinus* in the report of the Harriman Alaska Expedition probably belong in this category, but I have not yet had an opportunity to examine them.

3. LACCARIA Berk. & Br. Ann. Nat. Hist. 370. 1883

1. LACCARIA LACCATA (Scop.) Berk. & Br. Ann. Nat. Hist. 370. 1883

Seattle, Washington, *Murrill 289, 503, 656, 711;* Corvallis, Oregon, *Murrill 889,* Newport, Oregon, *Murrill 1041;* La Honda, California, *Murrill & Abrams 1249,* Berkeley, California, *Harper,* Stanford University, California, *Dudley 153, 172, 180, Nohara 35, Miss Patterson 46;* British Columbia, *A. I. Hill 44, 50, 84, 93.*

2. LACCARIA OCHROPURPUREA (Berk. & Curt.) Peck, Ann. Rep. N. Y. State Mus. **50**: 129. 1897

Seattle, Washington, *Murrill 334,* Tacoma Prairies, Washington, *Murrill 717;* Stanford University, California, *Nohara 34, M. T. Cook 4; Abrams 210.*

4. ARMILLARIA (Fries) Quél. Champ. Jura Vosg. 36. 1872

1. ARMILLARIA MELLEA (Vahl) Quél. Champ. Jura Vosg. 36. 1872

Seattle, Washington, *Murrill 703;* Salem, Oregon, *M. E. Peck 5, 21;* Golden Gate Park, San Francisco, California, *Murrill 1102,* La Honda, California, *Murrill & Abrams 1283,* Santa Cruz Mountains, California, *Dudley 105,* Searsville Lake, California, *McMurphy 13, 21,* Madera Creek, California, *McMurphy 1, 17, 40;* Pomona, California, *Baker 3937.*

2. ARMILLARIA ALBOLANARIPES Atk. Ann. Myc. **6**: 54. 1908

A very handsome species described from specimens collected near Corvallis, Oregon, by E. R. Lake in 1906. The description is correct in the main, except that the stipe is solid.

Corvallis, Oregon, *Lake, Murrill 1006;* Glen Brook, Oregon, *Murrill 771;* Newport, Oregon, *Murrill 1047;* Searsville Lake, California, *McMurphy 120, 121.*

3. ARMILLARIA SUBANNULATA Peck, Bull. Torrey Club **36**: 330. 1909

Pileus thick, fleshy, convex or broadly convex, subviscid, fibrillose, alutaceous, darker in the center where it is adorned with

reddish-brown fibrils, margin even; flesh white, odor and taste farinaceous; lamellae close, adnexed, white, sometimes becoming brown on the edges; stem equal, solid, subradicating, reddish-brown, white at the top, veil thick, soft, white, evanescent; spores ellipsoid, 10–12 × 8–9 μ.

Pileus 10–11 cm. broad; stem 9–15 cm. long, 2–3 cm. thick.

Described from specimens collected by Baker under oaks at Claremont, California. Types not seen.

4. **Armillaria arenicola** sp. nov.

Pileus firm, fleshy, convex to subplane or slightly depressed, gibbous, gregarious, 12–15 cm. broad; surface dry, smooth, glabrous, white or whitish, cremeous at the center; context coarse, white, tasteless; lamellae adnate, becoming sinuate-adnexed or nearly free, ventricose, plane, close, white, changing to rust-colored when bruised; spores globose, smooth, hyaline, 4–6 μ; stipe equal or tapering downward, dry, smooth below, somewhat scaly above the annulus, white tinged with cremeous, 12 cm. long, 3 cm. thick; annulus ample, persistent, membranous, white, attached just above the middle of the stipe.

Type collected in the sand hills among scrubby pines on the immediate coast at Newport, Oregon, November 13, 1911, *W. A. Murrill 1041*. A species remarkable for its size and habit of living in apparently pure sand, although the source of its food is doubtless buried humus. In general appearance, it resembles *Armillaria magnivelaris* Peck.

5. LIMACELLA Earle, Bull. N. Y. Bot. Gard. **5**: 447. 1909

1. **Limacella fulvodisca** (Peck)

Lepiota fulvodisca Peck, Bull. Torrey Club **22**: 198. 1895.

Described from specimens collected by McClatchie among leaves in woods near Pasadena, California, January, 1895.

Pasadena, California, *McClatchie;* Golden Gate Park, San Francisco, California, *Murrill 1101, 1105, 1112, 1119;* Stanford University, California, *Baker 159.*

2. **Limacella roseicremea** sp. nov.

Pileus convex to plane, with a broad umbo, slow to expand, solitary, 6 cm. broad; surface smooth, glabrous, viscid, cream-

colored tinted with rose, margin inflexed, not striate; context white, odor farinaceous; lamellæ free, rather close, arcuate, white; spores globose, smooth, corroded, apparently not maturing, white but not transparent, 4–5 μ; stipe subequal, enlarged at the base, white, fleshy, solid, smooth, glabrous, viscid, often very long, 5–10 × 0.8–1.2 cm.; veil ample, membranous, persistent, superior, remaining for some time stretched from margin to stipe.

Type collected on the ground in woods near Seattle, Washington, October 20–November 1, 1911, *W. A. Murrill 574*. Also collected in the region at the same time, *W. A. Murrill 534, 585*.

3. **Limacella McMurphyi** sp. nov.

Pileus fleshy, convex, solitary, 3.5–4 cm. broad; surface smooth, glabrous, evidently viscid when fresh, pinkish-cream-colored, not striate; context white, rather thick, with farinaceous taste and odor; lamellae free, crowded, inserted, ventricose, white; spores globose, smooth, hyaline, 3.5–4 μ; stipe slightly tapering upward, subglabrous, even, white, solid, 4–6 × 0.5–1 cm.; annulus superior, ample, persistent, white.

Type collected among leaves under redwoods near Searsville Lake, California, January 6, 1903, *James McMurphy 36*. The description is drawn from excellent field notes made by the collector. The species is distinguished from the preceding by its crowded, ventricose lamellae, and usually thicker stipe.

6. HYPONEVRIS Paulet, Icon. *pl. 1. f. 3–5.* 1812.

Schizophyllus Fries, Obs. Myc. **1**: 103. 1815.
Schizophyllum Fries, Syst. Myc. **1**: 330. 1821.

HYPONEVRIS ALNEUS (L.) Earle, Bull. N. Y. Bot. Gard. **5**: 412. 1909

Agaricus alneus L. Sp. Pl. 1176. 1753.
Agaricus multifidus Batsch, Elench. Fung. 173. *f. 126.* 1783.
Agaricus radiatus Sw. Prodr. 148. 1788. (Type from Jamaica.)
Schizophyllum commune Fries, Syst. Myc. **1**: 330. 1821.
Schizophyllum umbrinum Berk. Hook. Jour. Bot. **3**: 15. *pl. 1. f. 1.* 1851. (Type from Brazil.)
Schizophyllum fasciatum Pat. Jour. de Bot. **1**: 170. 1887. (Type from Mexico.)

Schizophyllum mexicanum Pat. Jour. de Bot. 1: 171. 1887. (Type from Mexico.)

Schizophyllum Egelingianum Ellis & Ev. Bull. Torrey Club 22: 439. 1895. (Type from Mexico.)

This species is one of the most common of all fungi, occurring on dead wood of various kinds in all lands. *Schizophyllum umbrinum* is a small, multifid, tropical form of this species, which appears much the same in all the collections at Paris and Kew, being represented there by specimens from Brazil, Surinam, French Guiana, Cuba, and Nicaragua. Specimens in the Ellis Herbarium from Nicaragua labeled *Schizophyllum multifidum digitatum* agree with this form. *S. pavonium,* from Mexico, in the Kew Herbarium, and *S. pusillum,* from Australia, at Upsala, are not distinct from *H. alneus,* and the description of *S. exiquum* Miq., from Surinam, leads one to believe that this also is a synonym. *Schizophyllum flabellare* Fries, a name occasionally assigned to American material, applies to a large and very distinct oriental species collected by Alfzelius in Guinea.

Seattle, Washington, *Frye;* Stanford University, California, *Dudley 147, Nohara 65, Miss Patterson 47; Abrams 147.*

7. RESUPINATUS (Nees) S. F. Gray, Nat. Arr. Brit. Pl. 1: 617. 1821

Resupinatus atrocoeruleus (Fries)

Agaricus (Pleurotus) atrocoeruleus Fries, Syst. Myc. 1: 190. 1821.

A cosmopolitan species easily recognized by its hairy surface and peculiar coloring.

California, *Harper 16.*

8. GEOPETALUM Pat. Hymén. Eur. 127. 1887

1. GEOPETALUM GEOGENIUM (DC.) Pat. Hymén. Eur. 127. 1887

For a description of this species, see MYCOLOGIA for January, 1912.

Seattle, Washington, *Murrill 288, 459, 584, Zeller.*

2. **Geopetalum porrigens** (Pers.)

Agaricus porrigens Pers. Obs. Myc. **1**: 54. 1796.
Seattle, Washington, *Murrill 519, Zeller 56.*

3. **Geopetalum oregonense** sp. nov.

Pileus thin, sessile, conchate to flabelliform, convex to expanded, milk-white throughout, gregarious on dead wood, reaching 1 cm.; surface smooth, glabrous, margin entire, incurved when young and on drying; lamellae subdistant, inserted, rather narrow, white, slightly yellowish when dry; spores pip-shaped, smooth, hyaline, 6–7 × 3–4 μ; stipe wanting, the pileus attached to a small, subglobose, white, tomentose mass.

Type collected on fallen dead deciduous branches at Mill City, Oregon, November 9, 1911, *W. A. Murrill 821.* Also collected at Corvallis, Oregon, November 6–11, 1911, on dead deciduous branches, *W. A. Murrill 916, 998.* Related to *Pleurotus candidissimus* (Berk. & Curt.) Sacc.

4. **Geopetalum subsepticum** sp. nov.

Pileus fleshy, thin, flexible, white throughout, dimidiate and conchate to subcircular or reniform, attached to dead grasses, twigs, trunks, and leaves, solitary, scarcely reaching 1 cm. in breadth; surface smooth, glabrous, margin lobed, inflexed on drying; lamellae subdistant, plane, inserted, white, yellowish-brown on drying; spores narrowly oblong, smooth, hyaline, 7–9 × 2–3 μ.

Type collected on dead leaves, etc., in woods near Seattle, Washington, October 20–November 1, 1911, *W. A. Murrill 413.* Also collected near Seattle, Washington, October 20–November 1, 1911, *W. A. Murrill 265, 533.* Related to *Pleurotus septicus,* but spore characters very different.

5. **Geopetalum densifolium** sp. nov.

Pileus fleshy, sessile, conchate to applanate, flabelliform, rather broadly attached, white throughout, gregarious, reaching 2 cm. broad; surface finely pubescent to subglabrous, smooth, margin entire, slightly inflexed on drying; lamellae very broad and very crowded, flaccid, overlapping on drying, white to isabelline, powdered with the spores, inserted, plane; spores ellipsoid, smooth, hyaline, 6–7 × 3.5 μ.

Type collected on dead deciduous wood in woods near Seattle, Washington, October 20–November 1, 1911, *W. A. Murrill 540.*

9. CREPIDOPUS (Nees) S. F. Gray, Nat. Arr. Brit. Pl. **1**: 616. 1821

1. CREPIDOPUS OSTREATUS (Jacq.) S. F. Gray, Nat. Arr. Brit. Pl. **1**: 616. 1821

Pleurotus ostreatus Quél. Champ. Jura Vosg. 77. 1872.

The white form of this species was found on decayed logs of alder, maple, and holly. I have never collected the dark European form in America.

Seattle, Washington, *Murrill 558;* Muir Woods, California, *Harper.*

2. **Crepidopus connatus** (Berk. & Curt.)

Agaricus (*Pleurotus*) *connatus* Berk. & Curt. Proc. Am. Acad. Arts & Sci. **4**: 115. 1858.

On an island in Bering Strait, Wright. Type not examined.

3. **Crepidopus serotinus** (Schrad.)

Pleurotus serotinus Quél. Ench. Fung. 149. 1886.

Pleurotus serotinoides Peck, Ann. Rep. N. Y. State Mus. **23**: 86. 1872.

Seattle, Washington, *Zeller 96;* British Columbia, *A. I. Hill 74.*

4. **Crepidopus subsapidus** sp. nov.

Pileus juicy, thin when dry, short-stipitate or attached by a narrow base, imbricate, spatulate to flabelliform, convex or plane, about 5 cm. broad; surface hygrophanous, smooth, glabrous, pallid to avellaneous; lamellae decurrent, somewhat furcate and anastomosing, inserted, rather close and narrow, thin, fragile, white, becoming pale-umbrinous on drying; spores narrowly oblong, pointed, smooth, lilac-tinted in mass, 8–9 × 3–3.5 μ; stipe, when present, short, lateral, white, strigose-tomentose at the base.

Type collected on an oak log in Muir Woods, California, November 22, 1911, *W. A. Murrill 1141.* Allied to the plant called *Pleurotus sapidus* in the eastern United States.

10. PLEUROTUS (Fries) Quél. Champ. Jura Vosg. 77. 1872

PLEUROTUS DRYINUS (Pers.) Quél. Champ. Jura Vosg. 77. 1872

This species is provided with a conspicuous veil and the surface is usually more or less areolate in appearance owing to the breaking up of the cuticle. *Pleurotus corticatus* (Fries) Quél. and *Pleurotus subareolatus* Peck are apparently not distinct. Found in Washington on decayed spots in living trunks of alder and large-leaved maple, sometimes reaching 13 cm. in breadth.

Seattle, Washington, *Murrill 386, 620.*

NEW COMBINATIONS

For the benefit of those accustomed to and desiring to use Saccardo's nomenclature, the following list of new combinations affecting some of the species described as new in this article and the previous one in MYCOLOGIA for March, 1912, is herewith appended.

CREPIDOPUS SUBSAPIDUS	= **Pleurotus subsapidus**
GEOPETALUM DENSIFOLIUM	= **Pleurotus densifolius**
GEOPETALUM OREGONENSE	= **Pleurotus oregonensis**
GEOPETALUM SUBSEPTICUM	= **Pleurotus subsepticus**
HYDROCYBE ARENICOLA	= **Hygrophorus arenicola**
HYDROCYBE CONSTANS	= **Hygrophorus constans**
HYDROCYBE CREMICOLOR	= **Hygrophorus cremicolor**
LIMACELLA MCMURPHYI	= **Lepiota McMurphyi**
LIMACELLA ROSEICREMEA	= **Lepiota roseicremea**
CERIOMYCES MIRABILIS	= **Boletus mirabilis**
CERIOMYCES OREGONENSIS	= **Boletus oregonensis**
CERIOMYCES ZELLERI	= **Boletus Zelleri**
CORIOLUS WASHINGTONENSIS	= **Polystictus washingtonensis**
SCUTIGER OREGONENSIS	= **Polyporus oregonensis**
SPONGIPELLIS SENSIBILIS	= **Polyporus sensibilis**
TYROMYCES CARBONARIUS	= **Polyporus carbonarius**
TYROMYCES CUTIFRACTUS	= **Polyporus cutifractus**
TYROMYCES PERDELICATUS	= **Polyporus perdelicatus**
TYROMYCES PSEUDOTSUGAE	= **Polyporus Pseudotsugae**
TYROMYCES SUBSTIPITATUS	= **Polyporus substipitatus**

NEW YORK BOTANICAL GARDEN.

ARTIFICIAL CULTURES OF ASCOBOLUS AND ALEURIA

B. O. Dodge

(With Plates 72 and 73, Containing 11 Figures)

Methods by which any considerable number of species of discomycetes can be successfully cultivated on artificial media have not as yet been worked out, and any additional information along this line may be of interest because of the value of such methods in connection with the study of the reproductive processes and the identification of species.

The writer has recently found a species of *Ascobolus* which seems to be quite different from any species described, both as to the characters recognized by the ordinary methods and those which can be brought out satisfactorily only by cultures from the germinated ascospores. The species has been under observation for about three months and has been grown on the natural substratum by transferring pieces of dung bearing young fruits, and has also been brought to maturity on agar media, the cultures having been started by germinating the ascospores by the methods already described (Bull. Torrey Club **39**: 139–197). A more detailed account of the methods of reproduction, determined by a study of the fungus in the artificial cultures, will be given later, such reproductive features being noted at this time as can be observed without resorting to artificial cultures.

Ascobolus magnificus sp. nov.

Ascocarps scattered or closely crowded together, sessile, at first globose, closed, white or whitish, opening by a pore, the smooth white margin inrolled, becoming deeply cup-shaped, the lower portion of the exterior appearing pruinose from the projecting tips of thin-walled, hair-like hyphal branches which later become discolored and brownish, finally expanding, exposing the pale greenish-yellow surface of the hymenium, .5–2.7 cm. in diameter; asci cylindric-clavate, 200–300 × 18–25 μ, I +, 8-spored;

paraphyses linear, slightly enlarged above, septate, frequently with greenish, granular contents, 5–7 μ; spores ellipsoid, at first hyaline, then pale-lilac, finally rose-purple or violet, smooth, marked on one side by a line extending from end to end or obliquely across the surface, irregularly distichous at maturity, 20–25 × 12–14 μ, usually germinating at only one germ-pore; archicarp consisting of a stalk of 3–4 thick cells, a somewhat spherical ascogenous cell 35–45 μ in diameter, and a trichogyne with 7–10 cells, the outer cells coiling sharply inward at the tip, the complete archicarp coiled in one plane.

On horse dung in damp chamber cultures, New York City, April, 1912; type specimens deposited in the herbarium of the New York Botanical Garden.

The principal characters which distinguish this species are the large size of the plants, the beautiful white margin, the line extending across the surface of the spore, a single germ-tube, and the large archicarp in a flat coil. *Ascobolus applanatus* (Rabh. & Gonn.) Rehm, which Rehm (Disc. p. 1131) considers a doubtful species, is said to be 2 cm. in diameter; as to the other characters noted, it does not resemble this species. *A. major* B. & C., and *A. sarawacensis* Ces. are large species with smooth spores. *A. latus* Penz. & Sacc. and *A. laevisporus* Speg. are evidently more nearly related to *A. magnificus* but differ in the spore markings.

The line along the surface of the spore is visible before the spore becomes colored, and is not in the nature of a crack in the epispore, although a crack frequently develops along this line when the ejected spore is allowed to dry out; under such conditions numerous other cracks are formed in all directions, giving the spore a reticulated appearance.

The pruinosity of the exterior of the ascocarp would probabiy not be noticeable were the fungus grown in the open. Even in damp chambers, when specimens (Pl. 72, f. 4) become fully expanded and flattened out on the substratum (Pl. 73, lower figure), this pruinosity is no longer evident.

The very hard and brittle character of the thick flesh of the hypothecium is indicated by the way in which the ascocarps crack while expanding. (Plate 73, upper figure.)

The asci do not project prominently above the surface of the

hymenium, and after the whole surface has become deeply colored purple with ripe spores, on lifting the cover of the damp chamber the spores will be shot off in a cloud, just as is commonly the case with many of the large fleshy discomycetes.

The damp chamber cultures in which this fungus made its appearance had been kept about two weeks in a Wardian case, where they were exposed to the direct sunlight during part of the day. The substratum had been heavily watered while yet fresh so that at this time the mass was in a very putrid condition. The excessively high temperatures prevailing in this room and the condition of the substratum may perhaps account for the production of mature fruit bodies in which no colored spores were formed. In these cases all ejected spores were perfectly hyaline. Many of these spores had already germinated within the asci, and they also germinated readily in agar media without special treatment. When, however, the cultures were removed to a cooler room, colored spores were formed. As it was difficult to obtain uncontaminated cultures on agar by using the uncolored spores, several plates were inoculated with the colored spores and heated for thirty minutes in an oven, the final temperature of the oven being about 70° C. Spores in all the plates germinated. The ascocarps do not mature well on the agar media and it has been more satisfactory to transplant pieces of agar containing the mycelium or young fruit bodies to the dung where the supply of nutrient is less limited. Plate 73, upper figure, shows a culture obtained in this manner.

While fully 50 per cent. of the spores germinated in the earlier experiments, in the case of spores gathered about ten days later not over 1 per cent. could be made to grow by the heating process, and none germinated without heating.

Pure cultures of the species have not been obtained on account of the presence of a fungus which is parasitic on the mycelium of the *Ascobolus*. This parasite forms large numbers of fruit bodies, consisting when young of a central cell enclosed by protecting hyphae. It has been possible to trace a direct connection between the mycelium of the parasite bearing these fruit bodies and the mycelium of the host bearing its characteristic archicarp. As no spores of any description have been discovered,

further investigation will be necessary before the identity of the parasite can be determined. Portions of the mycelia of the host and of the parasite are shown in Plate 72, figs. 7 and 8.

ALEURIA UMBRINA Boud.

This fungus grows on burned places during the early part of the season in the vicinity of New York City. The species has been identified by Dr. F. J. Seaver. The outer surface is coarsely warted, especially in young specimens, where the stipe imbedded in the earth is also seen to be well developed. *Plicaria echinospora* (Karst.) Rehm, has been recorded as growing on burned places and the two species are apparently closely related.

Pure cultures of this species may be obtained easily by growing the spores on an agar medium made up with an extract of heated soil. When the spores are heated to 70°–80° C. for fifteen minutes, as described under "*Ascobolus carbonarius*" (Bull. Torrey Club **39**: 139–197), germination is above 90 per cent. A large germ-tube is first formed and is usually followed later by a smaller one at the opposite end of the spore. (Pl. 72, f. 9.)

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EXPLANATION OF PLATE LXXII

Ascobolus magnificus Dodge

Fig. 1. (*a*) Ejected spores before drying. (*b*) After drying out the epispore is cracked in all directions. × 525. The width of the cracks is slightly exaggerated in the drawing.

Fig. 2. (*a*) Ungerminated spores. (*b*) Germinated spore. × 525.

Fig. 3. (*a*) Germinated spores. (*b*) A large spore much swollen. × 525.

Fig. 4. Section through an ascocarp showing hymenial layer and the tips of secondary mycelial hyphae (?) appearing as hairs on the exterior.

Fig. 5. Asci and paraphyses. (*a*) × 100; (*b*) × 300.

Fig. 6. Archicarp as it appears in youngest fruit bodies that can be seen with a hand lens. (*s*) The stalk; (*a*) ascogenous cell; (*t*) trichogyne. The size of the ascocarps at this time is indicated by the border line. × 150.

Figs. 7, 8. (*a*) Mycelium of a fungus parasitic on the mycelium. (*b*) Mycelium of the *Ascobolus*. × 525.

Aleuria umbrina Boud.

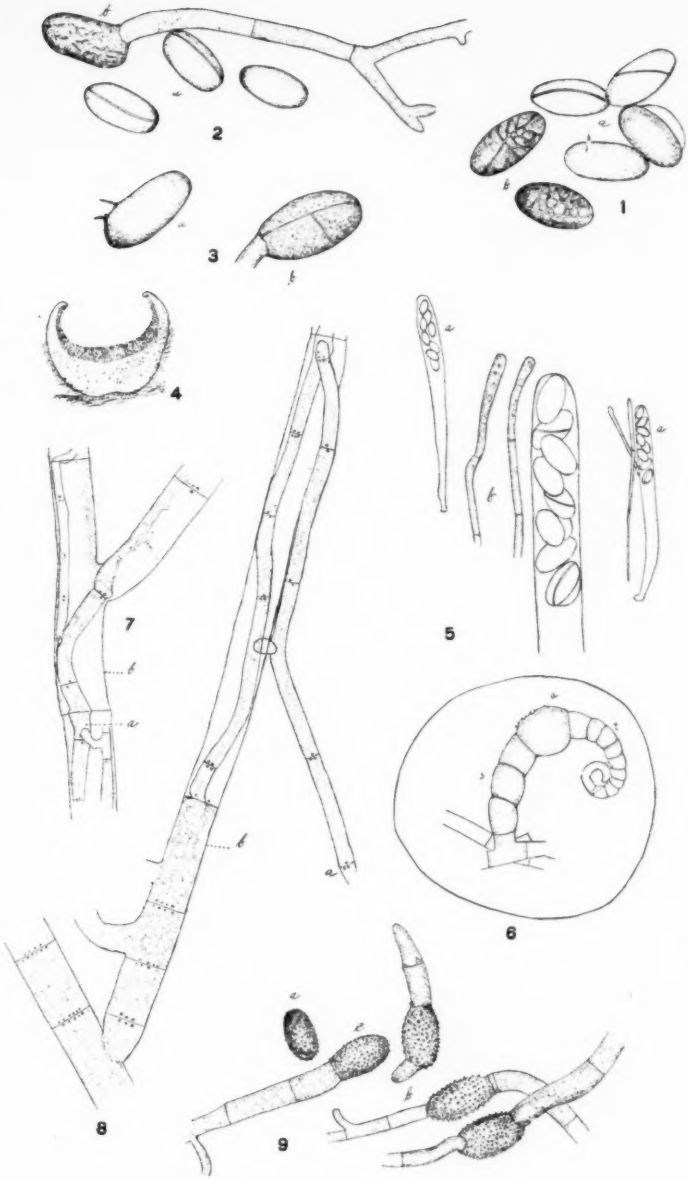
Fig. 9. (*a*) Ungerminated spore. (*b*) Germinated spores. (*c*) A spore with only one germ-tube. × 525.

EXPLANATION OF PLATE LXXIII

Ascobolus magnificus Dodge

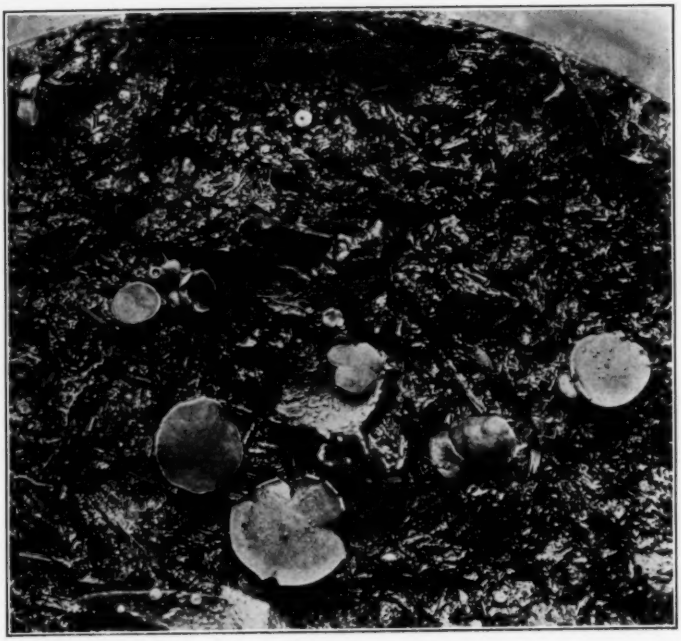
Two rather large ascocarps are shown natural size in the lower figure, the character of the white margin well brought out. At the extreme left may be seen two small fruit bodies. Seventeen ascocarps were later developed at this point, forming a compact mass of fruit bodies, each being about 1 cm. in diameter.

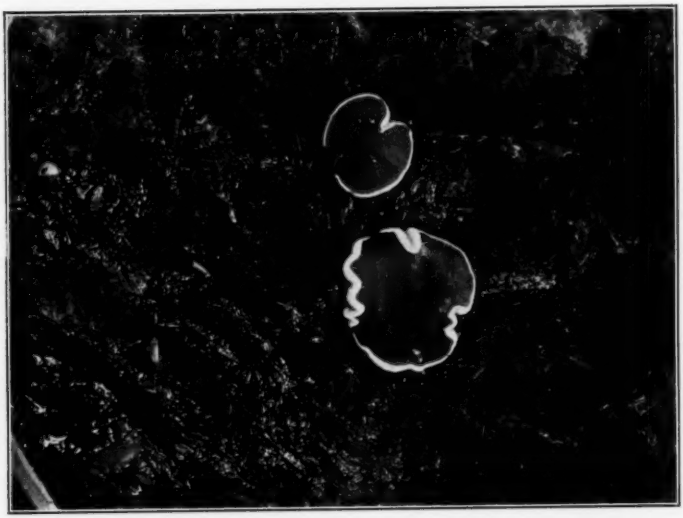
In the upper figure, are a number of young ascocarps showing the pore at the time of opening; the mature ascocarps are about the average size.



1–8. ASCOBOLUS MAGNIFICUS DODGE

9. ALEURIA UMBRINA BOUD.





ASCOBOLUS MAGNIFICUS DODGE

NEWS AND NOTES

The black canker of the chestnut tree, said to be due to the fungus, *Mycelophagus Castaneae,* which attacks the young roots and their mycorrhiza, has recently caused severe losses in France. The use of oak and Japanese chestnut stock has been suggested as a means of control.

Arnaud and Foëx have discovered the perithecia of the oak *Oidium* (Compt. Rend. **154**: 124–127. 1912) and they refer the fungus to *Microsphaera quercina.*

An expert examination by C. Wehmer of structural timbers attacked by dry rot has revealed the presence in many instances of *Coniophora cerebella* and *Poria vaporaria* associated with *Merulius lacrymans.*

Part 3, volume 7, of NORTH AMERICAN FLORA, by J. C. Arthur and F. D. Kern, appeared April 15, 1912. Eighteen genera of plant rusts are treated in the 108 pages, the American species of *Gymnosporangium* alone numbering 32 and of *Nigredo* (*Uromyces*) 83.

Professor Bruce Fink, of Miami University, Oxford, Ohio, desires to see fresh material in abundance of species of the Collemaceae collected in various parts of New York State. This group of lichens is greatly in need of careful modern taxonomic treatment and Professor Fink will devote much of his time to it during the next two years.

The results of morphological and physiological researches on the genus *Coprinus,* by J. R. Weir, under the direction of Professors Goebel and Loew, were published in *Flora* in 1911. The paper comprises 60 pages of text and 25 figures.

An exhaustive report, containing 175 pages and 14 plates, on the history and cause of cocoanut bud-rot, by J. R. Johnston, appeared in February, 1912, as Bulletin 228 of the Bureau of Plant Industry at Washington. The author considers this serious disease as bacterial in origin and amenable to control by ordinary methods of sanitation and proper cultivation.

The seventh annual report of the Forest Park Reservation Commission of New Jersey, which has just been distributed, contains valuable suggestions regarding forest and shade trees and their protection, with some particularly good advice concerning the chestnut canker and its progress in the state.

A series of papers on the hymenomycetes of Lappland, by Lars Romell, was begun in *Arkiv för Botanik* **2**: 1911, the first paper on the Polyporaceae, in which 12 species are described as new, comprising 35 pages and two double plates. These studies are of special interest to mycologists in this country because of the close relationship that exists between the plants of Lappland and boreal America.

A preliminary report of 116 pages on the gill-fungi of Ohio, with keys to genera and species, by W. G. Stover, has just appeared as part 9, volume 5, of the *Proceedings of the Ohio State Academy of Science*. This report is not only a guide to the species recognized but also to the literature describing them, and should prove valuable to students and others interested in the Ohio gill-fungi. The term "preliminary" is used very advisedly, as no one realizes better than Mr. Stover how much there is still to learn about this subject.

Observations on *Marasmius oreades*, the "fairy-ring" mushroom, have been made by Jessie Bayliss (Jour. Econ. Biol. **6**: 111–132. *pl.* 5–7. 1911) with the following results, as reviewed in the *Experiment Station Record* for April, 1912.

It was found that *M. oreades* lives parasitically on grass. It attacks young roots, killing them by means of some toxic secretion. The fungus at first exerts a stimulating influence, and the grass

assumes a darker color owing to better nitrogenous nutrition. This is believed to be due to the proteolytic enzymes acting on the dead roots. There can always be distinguished a zone of dark-green grass outside as well as inside the zone of dead grass. The infected soil was found very impervious to moisture, owing probably to the air which is entangled within the meshes of the mycelium. It is thought that the fungus secretes a substance toxic to itself so as not to be able to grow in the same soil three years in succession. During the second year the fungus dies and the grass gains the ascendency and flourishes, owing to the increased nitrogenous material available. The secretion of this toxic substance is believed to account for the disappearance of rings between the places of intersection when fairy rings meet.

Dr. E. D. Clark has called attention in the June *Torreya* to a recent brief paper by Radais and Sartory which shows the impossibility of removing certain of the most deadly poisons from fleshy fungi by treating them with hot water. His translation of this paper is, as follows:

"The autumn of 1911 has brought the usual outbreak of mushroom poisoning, with many fatal cases, caused primarily by eating *Amanita phalloides* Fr. The press considered that it was doing a useful thing in spreading among the people, with the authority of naturalists whose intentions were more laudable than their knowledge, the incorrect and dangerous notion that in treating the mushrooms with boiling water followed by repeated washing in cold water, all danger in eating them had been removed. For a long time mycologists have recognized that this treatment will often remove certain very soluble bitter and poisonous principles but they have never ceased to put people on their guard against the inefficiency of this method in the case of certain species, especially *Amanita phalloides*. The present seems to be an opportune time to confirm this caution with experiments. Our observations were made upon several poisonous species but with special reference to *A. phalloides*. We may sum up the results of our experiments in the following words: *A. phalloides* still preserves its toxic principle unchanged after being heated to boiling for some time; in the dried state its

toxicity is not weakened after standing a year nor has it lost its poisonous properties after remaining dry for six years; the poison is still held in the tissues of the mushroom after boiling with water.

"Therefore it is very unwise to spread broadcast the erroneous idea that all poisonous mushrooms may be rendered harmless by boiling with water and then washing repeatedly in cold water."

INDEX TO AMERICAN MYCOLOGICAL LITERATURE

This index is prepared by Dr. B. O. Dodge, of Columbia University, and covers the same scope for the fungi as that covered by the general index published monthly in the Bulletin of the Torrey Botanical Club. It is not reprinted on cards for distribution.

Arthur, J. C. *Aecidiaceae* (continuatio). N. Am. Fl. **7**: 161–187, 211–268. 15 Ap 1912.

The part on *Gymnosporangium*, pp. 188–211, contributed by F. D. Kern.

Berger, E. W. Report of entomologist. Rep. Univ. Florida Agr. Exp. Sta. **1911**: xl–lvii. 1912.

Also contains notes on "Fungus diseases of whitefly."

Brooks, C., & Black, C. A. Apple fruit spot and quince blotch. Phytopathology **2**: 63–72. *pl. 4, 5.* Ap 1912.

Reprinted in Sci. Contrib. New Hampshire Agr. Exp. Sta. **5**: 63–72. *pl. 4, 5.*

Dodge, B. O. Methods of culture and the morphology of the archicarp in certain species of the *Ascobolaceae*. Bull. Torrey Club **39**: 139–197. *pl. 10–15. f. 1, 2.* 17 My 1912.

Dox, A. W. Enzyme studies of lower fungi. Plant World **15**: 40–43. F 1912.

Farlow, W. G. The fungus of the chestnut-tree blight. Science II. **35**: 717–722. 10 My 1912.

Brings together material relating to the identity of *Diaporthe parasitica* Murrill, suggesting possible relationship with *Endothia radicalis*.

Fawcett, H. S. Report of plant pathologist. Rep. Univ. Florida Agr. Exp. Sta. **1911**: lviii–lxvii. *f 7–9.* 1912.

Gives a short account of the occurrence of fungi causing rot and gumming of peach and orange trees.

Floyd, B. F. Report of plant physiologist. Rep. Univ. Florida Agr. Exp. Sta. **1911**: lxviii–lxxxi. *f. 10–14.* 1912.

Contains reports on experiments to determine the relation of fertilizers to diseases that affect the orange tree. He concludes that if melanose is a fungus it exists only in the vegetative condition.

Fromme, F. D. Sexual fusions and spore development of the flax rust. Bull. Torrey Club **39**: 113–131. *pl. 8, 9.* 18 Ap 1912.

Giddings, W. J. The chestnut bark disease. W. Virginia Univ. Agr. Exp. Sta. Bull. 137: 209–225. *f. 1–12.* Mr 1912.

Harter, L. L. Diseases of cabbage and related crops and their control. U. S. Dept. Agr. Farm. Bull. 488: 5–32. *f. 1–7.* 15 Ap 1912.

Hasse, H. E. Additions to the lichen flora of southern California. No. 7 Bryologist **15**: 45–48. My 1912.

Lecidea bullata Hasse and *Mycoporellum Hassei*, A. Zahlbr. spp. nov. described.

Hedgcock, G. G. Notes on some diseases of trees in our national forests—II. Phytopathology **2**: 73–80. Ap 1912.

Hedgcock, G. G. Notes on some western *Uredineae* which attack forest trees. Mycologia **4**: 141–147. My 1912.

Hedgcock, G. G. & Long, W. H. Preliminary notes on three rots of juniper. Mycologia **4**: 109–114 *pl. 64, 65.* My 1912.

Fomes juniperinus, F. Earlei, and *F. texanus.*

Howe, R. H. *Oropogon loxensis* and its North American distribution. Mycologia **4**: 152–156. *f. 1, 2.* My 1912.

Howe, R. H. Some lichens from Nantucket Island, Massachusetts. Rhodora **14**: 88–90. 1 My 1912.

Howe, R. H. The lichens of the Linnean Herbarium with remarks on Acharian material. Bull. Torrey Club **39**: 199–203. 17 My 1912.

Kauffman, C. H. Mushrooms. Nat. Stud. Rev. 8: 172–181. *f. 1–4.* My 1912.

Discusses in popular style certain edible and poisonous fungi.

Kern, F. D. *Gymnosporangium.* N. Am. Fl. **7**: 188–211. 15 Ap 1912.

Lewis, C. E. Inoculation experiments with fungi associated with apple leaf spot and canker. Phytopathology **2**: 49–62. Ap 1912.

Lipman, C. B. Toxic effects of "alkali salts" in soils on soil bacteria. II. Nitrification. Centralb. Bakt. Zweite Abt. **33**: 305–313. *f. 1, 2.* 2 Mr 1912.

Lloyd, C. G. Synopsis of the stipitate polyporoids. 95–208. *f. 395–500.* Mr 1912. [Illust.]

Macbride, T. H. "The passing of the slime-moulds." Science II. **35**: 741–743. 10 My 1912.

Moore, C. L. Some Nova Scotian aquatic fungi. Trans. Nova Scotia Inst. Sci. **12**: 217–238. 18 Mr 1912.

Reed, G. M. Infection experiments with the powdery mildew of wheat. Phytopathology **2**: 81–87. Ap 1912.

Reynolds, E. S. Relations of parasitic fungi to their host plants —I. Studies of parasitized leaf tissue. Bot. Gaz. **53**: 365–395. *f. 1–9.* 15 My 1912.

Riddle, L. W. An enumeration of lichens collected by Clara Eaton Cummings in Jamaica—I. Mycologia **4**: 125–140. My 1912.

Lists 114 species and includes 11 new species, in *Biatora* (3), *Buellia* (1), *Catillaria* (1), *Megalospora* (2), *Bilimbia* (3), and *Erioderma* (1).

Seaver, F. J. The genus *Lasiosphaeria*. Mycologia **4**: 115–124. *pl. 66, 67.* My 1912.

Includes a key to the species, and figures of the fruit, asci, and spores in each case. *Lasiosphaeria multiseptata* and *L. jamaicensis* spp. nov. are also described.

Shear, C. L. The chestnut bark fungus, *Diaporthe parasitica*. Phytopathology **2**: 88, 89. Ap 1912.

Spaulding, P. Notes upon tree diseases in the eastern states. Mycologia **4**: 148–151. My 1912.

Among these diseases are the chestnut blight, *Lophodermium nervisequum*, *Peridermium fructigenum*, *Myxosporium acerinum*, and *Phoma piciena*.

Spaulding, P., & Field, E. C. Two dangerous imported plant diseases. U. S. Dept. Agr. Farm. Bull. 489: 5–29. *f. 1–3.* 9 Ap 1912.

Stout, A. B. A sclerotium disease of blue-joint and other grasses. Univ. Wisconsin Agr. Exp. Sta. Research Bull. 18: 207–253. *f. 1–8.* Mr 1912.

Stover, W. G. The *Agaricaceae* of Ohio. A preliminary report with keys to the genera and species. Proc. Ohio State Acad. Sci. **5**: 462–577. Mr 1912.

Sturgis, W. C. A guide to the botanical literature of the myxomycetes from 1875 to 1912. Colorado Col. Publ. Sci. **12**: 385–433. 1 Je 1912.

Theissen, F. *Hymenomycetes* riograndenses. Broteria **10**: 5–28. *pl. 1–4.* Ap 1912.

Theissen, F. Zur revision der Gattung *Dimerosporium.* Beih. Bot. Centralb. **29**: 45–73. 12 Ap 1912.
Includes several American species.

Whetzel, H. H., & Rosenbaum, J. The diseases of ginseng and their control. U. S. Dept. Agr. Plant Ind. Bull. 250: 7–44. *pl. 1–12. f. 1–5.* 30 Ap 1912.

Wolf, F. A. Gummosis. Plant World **15**: 60–66. Mr 1912.